Vol. 2

J. Wale inv. & del.

Ravenet sculp.

O Lord how manifold are thy Works! in wisdom haſt thou made them all, the Earth is full of thy Riches. —

Ps. CIV. v.24

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PHYSICO-THEOLOGY:

OR, A Gal 10 D 6.

DEMONSTRATION

OF THE

BEING and ATTRIBUTES of GOD,

FROM HIS

WORKS of CREATION.

Being the SUBSTANCE of

SIXTEEN SERMONS,

Preached in St. *Mary-le-Bow* Church, *London*.

At the Honourable Mr. *BOYLE*'s LECTURES,
in the Years 1711, and 1712.

With large *Notes*, and many curious *Obſervations*.

By W. DERHAM, D.D. *late Canon of* Windſor,
Rector of Upminſter *in* Eſſex, *and* F.R.S.

Mala & impia conſuetudo eſt contra Deos diſputare, ſive animo id ſit, ſive ſimulatè. Cic. de Nat. Deor. L. 2. fine.

VOL. II.

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PH
MVSEVM
BRITANNICVM

A
SURVEY
OF THE
Terraqueous GLOBE.

BOOK IV.

CHAP. XII.

Of the Cloathing of Animals.

HAVING in the foregoing chapter, ſomewhat largely taken a view of the infinite Creator's wiſdom and goodneſs towards his creatures, in ordering their food, I ſhall be more brief in this chapter, in my view of their Cloathing (*a*); another neceſſary appendage

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(*a*) Concerning the Cloathing of animals, *Ariſtotle* obſerves, 'That ſuch animals have hair as go 'on feet, and are viviparous; and that ſuch are covered with a ſhell, as go on feet, and are ovipa'rous.' *Hiſt. anim.* l. 3. c. 10.

appendage of life, and in which we have plain tokens of the Creator's art, manifeſted in theſe two particulars; the ſuitableneſs of animals Cloathing to their place and occaſions, and the garniture and beauty thereof.

I. The cloathing of animals is ſuited to their place of abode, and occaſions there; a manifeſt act of deſign and ſkill. For if there was a poſſibility, that animals could have been accoutred any other way, than by God that made them, it muſt needs have come to paſs, that their cloathing would have been at all adventures, or all made the ſame mode and way, or ſome of it, at leaſt, inconvenient and unſuitable. But, on the contrary, we find all is curious and compleat, nothing too much, nothing too little, nothing bungling, nothing but what will bear the ſcrutiny of the moſt exquiſite artiſt; yea, and ſo far out-do his beſt ſkill, that his moſt exquiſite imitations, even of the meaneſt hair, feather, ſcale, or ſhell, will be found only as ſo many ugly, ill-made blunders and botches, when ſtrictly brought to the teſt of good glaſſes. But we ſhall find an example remarkable enough in the preſent caſe, if we only compare the beſt of cloathing which man makes for himſelf, with that given by the Creator for the covering of the irrational creatures. Of which it may be ſaid, as our Saviour doth of the flowers of the field, *Matt.* vi. 29. 'That even Solomon, in all his glory, was not arrayed 'like one of theſe.' But

But let us come to particulars, and conſider the ſuitableneſs of the different method the Creator hath taken in the cloathing of man, and of the irrational animals. This *Pliny* (*b*) pathetically laments, and ſays, 'It is hard to judge, whether nature hath been a kinder parent, or more cruel ſtep-mother to man. For (ſays he) of all creatures, he alone is

(*b*) 'Cujus [hominis] cauſâ videtur cuncta alia genuiſſe natura, magnâ & ſævâ mercede contra tanta ſua munera: ut non ſit ſatis æſtimare, parens melior homini, an triſtior noverca fuerit. Ante omnia unum animantium cunctorum alienis velat opibus: cæteris variè tegumenta tribuit, teſtas, cortices, coria, ſpinas, villos, ſetas, pilos, plumam, pennas, ſquamas, vellera. Truncos etiam arboreſque cortice, interdum gemino, à frigoribus, & calore tutata eſt. Hominem tantùm nudum, & in nudâ humo, natali die abjicit ad vagitus ſtatim & ploratum, nullumque tot animalium aliud ad lacrymas, & has protinus vitæ principio.' Plin. *nat. hiſt. l.* 7. *Proœm.*

Let *Seneca* anſwer this complaint of *Pliny*, altho' perhaps what he ſaith might be more properly noted in another place; 'Quiſquis es iniquus æſtimator ſortis humanæ, cogita quanta nobis tribuerit parens noſter, quanto valentiora animalia ſub jugum miſerimus, quanto velociora aſſequamur, quam nihil ſit mortale non ſub ictu noſtro poſitum. Tot virtutes accepimus, tot artes, animum denique cui nihil non eodem quo intendit momento pervium eſt, ſideribus velociorem, &c.' Senec. *de benef. l.* 2. *c.* 29.

'covered with others riches; whereas nature 'hath given various cloathing to other animals, ſhells, hides, prickles, ſhag, briſtles, 'hair, down, quills, ſcales, fleeces; and trees 'ſhe hath fenced with a bark or two againſt 'the injuries of cold and heat. Only poor 'naked man (ſays he) is in the day of his 'birth caſt into the wide world, to immediate 'crying and ſqualling, and none of all creatures beſides, ſo ſoon to tears in the very 'beginning of their life.'

But here we have a manifeſt demonſtration of the care and wiſdom of God towards his creatures: that ſuch ſhould come into the world with their bodies ready furniſhed and accommodated, who had neither reaſon nor forecaſt to contrive, nor parts adapted to the artifices and workmanſhip of cloathing; but for man, he being endowed with the tranſcending faculty of reaſon, and thereby made able to help himſelf, by having thoughts to contrive, and withal hands to effect, and ſufficient materials (*c*) afforded him from the ſkins

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(*c*) 'Mirantur plurimi quomodo tutè, & ſanè vivant homines in horrendis frigoribus plagæ ſeptentrionalis; hancque levem quæſtionem ultra 30 'annos audieram in Italiâ, præſertim ab Æthiopibus, & Indis, quibus oneroſus videtur veſtitus 'ſub Zonâ torridâ.----- Quibus reſpondetur,----- 'Gaudet Indus multiplici plumarum genere, magis 'forſan pro tegumento, quàm neceſſitate: rurſus 'Scytha villoſo veſtitu.----Ita ſub polo Arctico ad-'verſùs

ſkins and fleeces of animals, and from various trees and plants: Man, I ſay, having all this proviſion made for him, therefore the Creator hath

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‘ versùs aſperrimas hyemes----opportuna remedia ‘ faciliter adminiſtrat [natura] ligna videlicet in ‘ maximâ copiâ, & leviſſimo pretio, & demum pel- ‘ les diverſorum animalium, tam ſylveſtrium quàm ‘ domeſticorum.’ Then he gives a catalogue of them, and ſaith, ‘ Quorum omnium experti pel- ‘ lifices ita ingenioſè noverunt mixturas compo- ‘ nere, ut pulcherrimum decorem oſtendat varietas, ‘ & calidiſſimum fomentum adjuncta mollities.’ Ol. Mag. *Hiſt.* *l.* 6. *c.* 20.

To this guard againſt the cold, namely, of fire and cloathing, I hope the reader will excuſe me, if I take this opportunity of adding ſome other defenſatives, nature (or rather the great author of nature) hath afforded theſe northern regions: Such are their high mountains, abounding, as *Ol. Magnus* ſaith, through all parts; alſo their numerous woods, which, beſides their fire, do, with the mountains, ſerve as excellent ſcreens againſt the cold piercing air, and winds. Their prodigious quantities of minerals, and metals alſo afford heat, and warm vapours, ‘ Mineræ ſeptentrionalium regionum ſatis ‘ multæ, magnæ, diverſæ, & opulentæ ſunt,’ ſaith the ſame curious, and (for his time) learned archbiſhop, *l.* 6. *c.* 1. and in other places. And for the warmth they afford, the volcano’s of thoſe parts are an evidence; as are alſo their terrible thunder and lightning, which are obſerved to be the moſt ſevere and miſchievous in their metalline mountains, in which large herds of cattle are ſometimes deſtroy’d, the rocks ſo rent and ſhatter’d, that hath wiſely made him naked, and left him to ſhift for himſelf, being ſo well able to help himſelf.

And

new veins of ſilver are thereby diſcover'd; and a troubleſome kind of quinſey is produced in their throats, by the ſtench and poiſonous nature of the ſulphureous vapours; which they diſſolve, by drinking warm beer and butter together, as *Olaus* tells us in the ſame book, *chap.* 11.

To all which defenſatives, I ſhall in the laſt place add, the warm vapours of their lakes (ſome of which are prodigiouſly large, of 130 Italian miles in length, and not much leſs in breadth) alſo of their rivers, eſpecially the vapours which ariſe from the ſea. Of which guard againſt ſevere cold, we have lately had a convincing proof in the Great Froſt, in 1708; wherein, when *England*, *Germany*, *France*, *Denmark*, yea, the more ſoutherly regions of *Italy*, *Switzerland*, and other parts, ſuffer'd ſeverely, *Ireland* and *Scotland* felt very little of it, hardly more than in other winters; of the particulars of which, having given an account in the *Philoſ. Tranſact.* N° 324. I ſhall thither refer the reader. But it ſeems, this is what doth ordinarily befal thoſe northern parts; particularly the iſlands of *Orkney*, of which the learned Dr. *Wallace* gives this account;
' Here the winters are generally more ſubject to
' rain than ſnow; nor doth the froſt and ſnow
' continue ſo long here as in other parts of *Scot-*
' *land*; but the wind in the mean time will often
' blow very boiſterouſly; and it rains ſometimes,
' not by drops, but by ſpouts of water, as if whole
' clouds fell down at once. In the year 1680, in
' the month of *June* after great thunder, there
' fell

And a notable act this is of the wiſdom of God, not only as the mere ſetting forth his care and kindneſs to them that moſt needed his help, the helpleſs irrational animals, and in his not over-doing his work; but alſo as it is moſt agreeable to the nature and ſtate of man (*d*), both on natural and political accounts. That man ſhould cloath himſelf, is moſt agreeable to his nature, particularly (among other things) as being moſt ſalutary, and moſt ſuitable to his affairs. For by this means, man can adapt his cloathing to all ſeaſons, to all climates, to this, or to any buſineſs. He can hereby keep himſelf ſweet and clean, fence off many injuries; but above all, by this method of cloathing, with the natural texture of his

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'feil flakes of ice near a foot thick.' Wall. *Account of* Orkney, *ch.* 1. *p.* 4. From which laſt paſſage I obſerve, that altho' in thoſe parts, the atmoſphere near the earth be warm, it is exceſſively cold above, ſo as to freeze ſome of thoſe ſpouts of water in their deſcent, into ſuch great, and almoſt incredible, maſſes of hail. And whence can this warmth proceed, but from the earth or ſea, emitting heat ſufficient to ſtave off the cold above? Conſult *book* ii. *chap.* 5. *note* (*e*).

(*d*) 'Sicut enim ſi innata ſibi [i. e. homini] aliqua haberet arma, illa ei ſola ſemper adeſſent, ita & ſi artem aliquam naturâ ſortitus eſſet, reliquas ſanè non haberet. Quia verò ei meliùs erat omnibus armis, omnibuſque artibus uti, neutrum eorum à naturâ ipſi propterea datum eſt.' Galen. *de uſ. part. l.* 1. *c.* 4.

his ſkin adapted to it, it is that the grand means of health, namely, inſenſible perſpiration (*e*), is performed, at leaſt greatly promoted, without which an human body would be ſoon over-run with diſeaſes.

In the next place, there are good political reaſons for man's cloathing himſelf, inaſmuch as his induſtry is hereby employed in the exerciſes of his art and ingenuity; his diligence and care are exerted in keeping himſelf ſweet, cleanly, and neat; many callings and ways of life ariſe from thence, and (to name no more) the ranks and degrees of men are hereby,

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(*e*) Concerning inſenſible perſpiration, *Sanctorius* obſerves, that it much exceeds all the ſenſible put together. *De ſtat. med. Aph.* 4. That as much is evacuated by inſenſible perſpiration in one day, as is by ſtool in fourteen days: Particularly, that, in a night's time, about ſixteen ounces is commonly ſent out by urine, four ounces by ſtool; but above forty ounces by inſenſible perſpiration, *Aphor.* 59, 60. That if a man eats and drinks eight pounds in a day, five pound of it is ſpent in inſenſible perſpiration, § 1. *Aph.* 6. And as to the times, he ſaith, 'Ab aſſumpto cibo 5 horis 1 *lib.* circiter perſpira-'bilis----exhalare ſolet, à 5a ad 12 am 3 *lib.* cir-'citer; à 12a ad 16 am vix ſelibram, *Aph.* 56.

And as to the wonderful benefits of inſenſible perſpiration, they are abundantly demonſtrated by the ſame learned perſon, *ubi ſupra*; as alſo by *Borelli* in his ſecond part *de mot. animal. prop.* 168. who ſaith, 'Neceſſaria eſt inſenſibilis tranſpiratio, 'ut vita animalis conſervetur.'

by, in ſome meaſure, rendered viſible to others, in the ſeveral nations of the earth.

Thus it is manifeſtly beſt for man, that he ſhould cloath himſelf.

But for the poor ſhiftleſs irrationals, it is a prodigious act of the great Creator's indulgence, that they are all ready furniſhed with ſuch cloathing, as is proper to their place and buſineſs (*f*). Some covered with hair (*g*), ſome

(*f*) 'Animantium verò quanta varietas eſt? Quanta ad eam rem vis, ut in ſuo quæque genere permaneant? Quarum aliæ coriis tectæ ſunt, aliæ villis veſtitæ, aliæ ſpinis hirſutæ: plumâ alias, alias ſquamâ videmus obductas, alias eſſe cornibus armatas, alias habere effugia pennarum.' Cic. *de nat. deor. l.* 2. *c.* 47.

(*g*) From *Malpighi*'s curious obſervations of the hair, I ſhall note three things: 1. Their ſtructure is fiſtulous, or tubular; which hath long been a doubt among the curious. 'Fiſtuloſum [eſſe pilum] demonſtrat luſtratio pilorum à caudâ & collo equorum, &c.------ præcipuè ſetarum apri, quæ patentiorem ex fiſtulis compoſitionem exhibent. Eſt autem dictus apri pilus cylindricum corpus quaſi diaphanum-----fiſtularum aggere conflatum, & ſpeciem columnæ ſtriatæ præ ſe fert. Componentes fiſtulæ in gyrum ſituatæ in apice patentiores redduntur; nam hians pilus in geminas dividitur partes, & componentes minimæ fiſtulæ-- liberiores redditæ manifeſtantur, ita at enumerari poſſint; has autem 20, & ultra numeravi.------ Expoſitæ fiſtulæ----tubuloſæ ſunt, & frequentibus tunicis tranſverſaliter ſituatis, veluti vulvulis pollent.

ſome feathers (*b*), ſome with ſcales, ſome with

'lent. Et quoniam ſpinæ, in erinaceis præcipuè, '&c. nil aliud ſunt, quam duri & rigidi pili, ideo, &c.' And then he deſcribes the Hedge-hog's ſpines, in which thoſe tubes manifeſtly appear; together with medullary valves and cells; not inelegant, which he hath figured in *Tab.* 16. at the end of his works.

That which this ſagacious, and not enough to be commended obſerver, took notice of in the ſtructure of hair, and its parity to the ſpines, I have myſelf obſerved in ſome meaſure to be true, in the hair of Cats, Rats, Mice, and divers other animals; which look very prettily when viewed with a good microſcope. The hair of a Mouſe (the moſt tranſparent of any I have viewed) ſeems to be one ſingle tranſparent tube, with a pith made up of a fibrous ſubſtance, running in dark lines; in ſome hairs tranſverſly, in others ſpirally, as in *fig.* 14, 15, 16, 17. Theſe darker medullary parts, or lines, I have obſerved, are no other than ſmall fibres convolved round, and lying cloſer together than in other parts of the hair. They run from the bottom to the top of the hair; and, I imagine, ſerve to the gentle evacuation of ſome humour out of the body: Perhaps, the hair ſerves as well for the inſenſible perſpiration of hairy animals, as to fence againſt cold and wet. In *fig.* 14, 16, is repreſented the hair of a mouſe, as it appears, through a ſmall magnifier; and in *fig.* 15, 17, as it appears, when viewed with a larger magnifier.

Upon another review, I imagine, that although in *fig.* 14, 15. the dark parts of the pith ſeem to be tranſverſe, that they, as well as in the two other figures, run round in a ſcrew-like faſhion.

(*b*) See *book* vii. *chap.* 1. *note* (*d*), (*e*).

with ſhells (*i*), ſome only ſkin, and ſome with firm and ſtout armature; all nicely accommodated to the element in which the creature liveth, and its occaſions there (*k*). To quadrupeds, hair is a commodious cloathing; which, together with the apt texture of their ſkin, fitteth them for all weathers, to lie on the ground, and to do the offices of man: and thick and warm furs and fleeces of others, are not only a good defenſative againſt the cold and wet; but alſo a ſoft bed to repoſe themſelves in; and to many of them, a comfortable covering, to nurſe and cheriſh their tender young.

And as hair to quadrupeds, ſo feathers are as commodious a dreſs to ſuch as fly in the air; to birds, and ſome inſects, not only a good guard againſt wet and cold, and a comfortable covering to ſuch as hatch and brood their young; but alſo moſt commodious for their flight.

(*i*) See *chap.* 14. *note* (*c*).

(*k*) It is a ſign ſome wiſe artiſt was a contriver of the cloathing of animals, not only as their cloathing varies, as their way of living doth; but alſo becauſe every part of their bodies is furniſhed with proper, ſuitable cloathing. Thus divers animals, that have their bodies covered for the moſt part with ſhort, ſmooth hair, have ſome parts left naked, where hair would be an annoyance; and ſome parts beſet with long hair, as the mane and tail; and ſome with ſtiff, ſtrong briſtles, as about the noſe; and ſometimes within the noſtrils, to guard off, or give warning of annoyances.

flight. To which purpoſe they are nicely and neatly placed every where on the body, to give them an eaſy paſſage through the air (*l*), and to aſſiſt in the wafting their body through that thin medium. For which ſervice, how curious is their texture for lightneſs, and withal for ſtrength? Hollow and thin for lightneſs, but withal, context and firm for ſtrength. And where it is neceſſary they ſhould be filled, what a light and ſtrong medullary ſubſtance it is they are filled with? by which curious contrivances, even the very heavieſt parts made for ſtrength, are ſo far from being a load to the body, that they rather aſſiſt in making it light and buoyant, and capacitate it for flight. But for the vanes, the lighteſt part of the feather, how curiouſly are they wrought with capillary filaments, neatly interwoven together (*m*); whereby they are not

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(*l*) The feathers being placed from the head towards the tail, in cloſe and neat order, and withal preened and dreſſed by the contents of the oil-bag, afford as eaſy a paſſage thro' the air, as a boat new cleaned and dreſſed finds in its paſſage through the waters. Whereas, were the feathers placed the contrary, or any other way (as they would have been, had they been placed by chance, or without art) they would then have gathered air, and been a great incumbrance to the paſſage of the body through the air. See *book* vii. *chap.* 1. *note* (*b*).

(*m*) In *book* viii. *chap.* 1. *note* (*e*), there is a particular account of the mechaniſm of their vanes, from ſome nice microſcopical obſervations; and therefore I ſhall take no farther notice of it here.

not only light, but alſo ſufficiently cloſe and ſtrong, to keep the body warm, and guard it againſt the injuries of weather, and withal, to impower the wings, like ſo many ſails, to make ſtrong impulſes upon the air in their flight (*n*). Thus curious, thus artificial, thus commodious is the cloathing of beaſts and birds: Concerning which, more in its proper place.

And no leſs might I ſhew that of reptiles and fiſhes (*o*) to be, if it was convenient to enlarge upon this branch of the Creator's work. How well adapted are the annuli of ſome reptiles, and the contortions of the ſkin of others, not only to fence the body ſufficiently againſt outward injuries, but to enable them to creep, to perforate the earth (*p*); and in a word, to perform all the offices of their reptile

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(*n*) *Vide* Borell. *de mot. anim. prop.* 182. *vol.* I.

(*o*) See *book* ix.

(*p*) For a ſample of this branch of my ſurvey, let us chuſe the teguments of Earth-worms, which we ſhall find compleatly adapted to their way of life and motion, being made in the moſt compleat manner poſſible for terebrating the earth, and creeping where their occaſions lead them: For their body is made throughout of ſmall rings, and theſe rings have a curious apparatus of muſcles, enabling thoſe creatures with great ſtrength to dilate, extend, or contract their annuli, and whole body: Thoſe annuli alſo are each of them armed with ſmall, ſtiff, ſharp beards or prickles, which they can open, to lay hold on, or ſhut up cloſe to their body: And reptile ſtate, much better than any other tegument of the body would do? And the ſame might be ſaid of the covering of the inhabitants of the waters, particularly the ſhells of ſome, which are a ſtrong guard to the tender body that is within, and conſiſtent enough with their ſlower motion; and the ſcales and ſkins of others, affording them an eaſy and ſwift paſſage through the waters. But it may be ſufficient to give only a hint of theſe things, which more properly belong to another place.

Thus hath the indulgent Creator furniſhed the whole animal world with convenient, ſuitable cloathing.

II Let us, in the next place, take a ſhort view of the garniture (*q*), and beauty thereof. And here we ſhall thus far, at leaſt, deſcry it to be beautiful; that it is compleat and workman-like. Even the cloathing of the moſt ſordid

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laſtly, under the ſkin there lies a ſlimy juice, that they emit, as occaſion is, at certain perforations between the annuli, to lubricate the body, and facilitate their paſſage into the earth. By all which means they are enabled, with great ſpeed, eaſe, and ſafety, to thruſt and wedge themſelves into the earth; which they could not do, had their bodies been covered with hair, feathers, ſcales, or ſuch like cloathing of the other creatures. See more concerning this animal, *book* ix. *chap.* 1. *note* (*s*).

(*q*) *Ariſtotle*, in his *hiſt.anim. l.* 3. *c.* 12. names ſeveral rivers, that by being drank of, change the colour of the hair.

ordid animals, thoſe that are the leaſt beau-ified with colours, or rather whoſe cloathing nay regrate the eye (*r*); yet when we come tricly to view them, and ſeriouſly conſider he nice mechaniſm of one part, the admira-le texture of another, and the exact ſymme-ry of the whole; we diſcern ſuch ſtrokes of nimitable ſkill, ſuch incomparable curioſity, hat we may ſay with Solomon, *Eccl.* iii. 11. [God] hath made every thing beautiful in his time.'

But for a farther demonſtration of the ſuper-eminent dexterity of his almighty hand, e hath been pleaſed, as it were on purpoſe, o give ſurprizing beauties to divers kinds of nimals. What radiant colours are many of hem, particularly ſome birds and inſects (*s*), edecked with! what a prodigious combina-

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(*r*) For an example, let us take the cloathing of he Tortoiſe and Viper; becauſe, by an incurious iew, it rather regrateth, than pleaſeth the eye: But yet, by an accurate ſurvey, we find the ſhells of the former, and the ſcales of the latter, to be a curious piece of mechaniſm, neatly made, and ſo compleatly, and well put and tacked together, as o exceed any human compoſures: Of the latter, ee more in *book* ix. *chap.* 1. *note* (*c*).

(*s*) It would be endleſs to enter into the particu-ars of the beautiful birds and inſects of our Euro-ean parts; but eſpecially thoſe inhabiting the countries between the tropicks, which are obſerved as much to exceed our birds in their colours, as ours do theirs in their ſinging.

tion is there often of theſe, yea, how nice an air frequently of meaner colours (*t*), as to captivate the eye of all beholders, and exceed the dexterity of the moſt exquiſite pencil to copy?

And now, when we thus find a whole world of animals, cloathed in the wiſeſt manner, the moſt ſuitable to the element in which they live, the place in which they reſide, and their ſtate and occaſions there; when thoſe that are able to ſhift for themſelves, are left to their own diſcretion and diligence, but the helpleſs well accouter'd and provided for; when ſuch incomparable ſtrokes of art and workmanſhip appear in all, and ſuch inimitable glories and beauties in the cloathing of others; who can, without the greateſt obſtinacy and prejudice, deny this to be God's handy-work? The gaudy, or even the meaneſt apparel, which man provideth for himſelf, we readily enough own to be the contrivance, the work of man: And ſhall we deny the cloathing of all the animal world beſides (which infinitely ſurpaſſeth all the robes of earthly majeſty; ſhall we, dare we, deny that) to be the work of any thing leſs than of an infinite, intelligent being, whoſe art and power are equal to ſuch glorious work!

(*t*) The Wry-neck, at a diſtance, is a bird of mean colour; neither are indeed its colours radiant, or beautiful, ſingly conſider'd: But when it is in the hand, we ſee its light and darker colours ſo curiouſly mix'd together, as to give the bird a ſurprizing beauty. The ſame is alſo obſervable in many inſects, particularly of the Phalæna-kind.

CHAP. XIII.

Of the Houſes and Habitation of Animals.

HAVING in the laſt chapter, as briefly as I well could, ſurveyed the Cloathing of animals, I ſhall in this take a view of their Houſes, Neſts, their Cells and Habitations, another thing no leſs neceſſary to their well-being than the laſt; and in which the great Creator hath likewiſe ſignalized his care and ſkill, by giving animals an architectonick faculty, to build themſelves convenient places of retirement, in which to repoſe and ſecure themſelves, and to nurſe up their young.

And here, as before, we may conſider the caſe of man, and that of the irrational animals. Man having (as I ſaid) the gift of reaſon and underſtanding, is able to ſhift for himſelf, to contrive and build, as his pleaſure leads him, and his abilities will admit of. From the meaneſt huts and cottages, he can erect himſelf ſtately buildings, bedeck them with exquiſite arts of architecture, painting, and other garniture; enoble them, and render them delightful with pleaſant gardens, fountains, avenues, and what not? For man therefore the Creator hath abundantly provided in this reſpect, by giving him an ability to help himſelf. And a wiſe proviſion this is, inaſmuch as it is an excellent exerciſe of the wit, the ingenuity, the induſtry, and care of man.

But ſince ingenuity, without materials, would be fruitleſs, the materials therefore which the Creator hath provided the world with, for this very ſervice of building, deſerve our notice. The great variety of trees (*a*), earth, ſtones, and plants, anſwering every occaſion and purpoſe of man for this uſe, in all ages and places all the world over, is a great act of the Creator's goodneſs; as manifeſting, that ſince he has left man to ſhift for himſelf, it ſhould not be without ſufficient helps to enable him to do ſo, if he would but make uſe of them, and the ſenſe and reaſon which God hath given him.

Thus ſufficient proviſion is made for the habitation of man.

And no leſs ſhall we find is made for the reſt of the creatures; who, altho' they want the power of reaſon to vary their methods, and cannot add to, or diminiſh from, or any way

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(*a*) ------*Dant utile lignum*
Navigiis pinos, domibus cedroſque, cupreſſoſque :
Hinc radios trivere rotis, hinc tympana plauſtris
Agricolæ, & pandas ratibus poſuere carinas.
Viminibus ſalices fœcundæ, frondibus ulmi ;
At myrtus validis haſtilibus, & bona bello
Cornus ; ityræos taxi torquentur in arcus.
Nec tiliæ leves, aut torno raſile buxum,
Non formam accipiunt, ferroque cavantur acuto :
Necnon & torrentum undam levis innatat alnus
Miſſa pado : necnon & apes examina condunt
Corticibuſque cavis, vitioſæque ilicis alveo.
Virg. Georg. l. 2. carm. 442.

way make improvements upon their natural way, yet we find that natural inſtinct which the creator's infinite underſtanding hath imprinted in them, to be abundantly ſufficient, nay, in all probability, the very beſt or only method they can take, or that can be invented, for the reſpective uſe and purpoſe of each peculiar ſpecies of animals (*b*). If ſome creatures make their neſts in houſes, ſome in trees, ſome in ſhrubs, ſome in the earth (*c*), ſome in

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(*b*) See *chap.* 15. and *book* viii. *chap.* 6.

(*c*) Many of the Veſpæ Ichneumones are remarkable enough for their nidification and proviſion for their young. Thoſe that build in earth (which commonly have golden and black rings round their alvi) having lined the little cells they have perforated, lay therein their eggs, and then carry into them maggots from the leaves of trees, and ſeal them up cloſe and neatly. And another Ichneumon more of the Veſpa than Muſca-Ichneumon kind (having a little ſting in its tail, of a black colour) gave me the pleaſure, one ſummer, of ſeeing it build its neſt in a little hole in my ſtudy-window. This cell was coated about with an odoriferous, reſinous gum, collected, I ſuppoſe, from ſome fir-trees near; after which it laid two eggs (I think the number was) and then carried in divers maggots, ſome bigger than itſelf. Theſe it very ſagaciouſly ſealed cloſe up into the neſt, leaving them there, doubtleſs, partly to aſſiſt the incubation; and eſpecially for food to the future young, when hatched.

Of this article of theſe Ichneumons, *Ariſtotle* himſelf takes notice (but I believe he was ſcarce aware of in ſtone, ſome in the waters, ſome here, and ſome there, or have none at all; yet we find, that that place, that method of nidification, doth abundantly anſwer the creatures uſe and occaſions. They can there ſufficiently and well repoſe, and ſecure themſelves, lay, and breed up their young. We are ſo far from diſcovering any inconvenience in any of their reſpective ways, from perceiving any loſs befal the ſpecies, any decay, any periſhing of their young; that, in all probability, on the contrary, in that particular way they better thrive, are more ſecure, and better able to ſhift for, and help themſelves. If, for inſtance, ſome beaſts make to themſelves no habitation, but lie abroad in the open air, and there produce their young; in this caſe we find there is no need it ſhould be otherwiſe, by reaſon they are either taken care of by man

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of the eggs ſealed up with the ſpiders) Οἱ δε Σφῆκες Ἰχνεύμονες καλούμενοι, &c. ‘ As to the Veſpæ, call'd ‘ Ichneumones (leſs than others) they kill Spiders, ‘ and carry them into their holes, and having ſealed ‘ them up with dirt, they therein hatch, and pro‑ ‘ duce thoſe of the ſame kind.’ *Hiſt. anim. l.* 5. *c.* 20.

To what hath been ſaid about theſe Ichneumon Waſps, I ſhall add one obſervation more, concerning the providential ſtructure of their mouth in every of their tribes; *viz.* their jaws are not only very ſtrong, but nicely ſized, curved, and placed for gnawing and ſcraping thoſe complete little holes they perforate in earth, wood, yea, in ſtone itſelf.

man (*d*), or in no danger, as other creatures, from abroad. If others repoſite their young in holes (*e*) and dens, and ſecure themſelves alſo therein, it is, becauſe ſuch guard, ſuch ſecurity, is wanting, their lives being ſought either by the hoſtility of man, or to ſatisfy the appetite of rapacious creatures (*f*). If among birds, ſome build their neſts cloſe, ſome open, ſome with this, ſome with another material, ſome in houſes, ſome in trees, ſome on the ground (*g*), ſome on rocks and crags

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(*d*) *Tully* having ſpoken of the care of ſome animals towards their young, by which they are nurſed and brought up, ſaith, 'Accedit etiam, ad nonnullorum animantium, & earum rerum quas terra gignit, conſervationem, & ſalutem, hominum etiam ſolertia & diligentia. Nam multæ & pecudes, & ſtirpes ſunt, quæ ſine procuratione hominum ſalvæ eſſe non poſſunt.' Cic. *de nat. deor.* *l.* 2. *c.* 52.

(*e*) *Prov.* xxx. 26. 'The Conies are but a feeble folk, yet make they their houſes in the rocks.'

(*f*) See *note* (*l*).

(*g*) It is a notable inſtinct which *Ol. Magnus* tells us of the Galli Sylveſtres, in his northern country, to ſecure themſelves againſt the cold and ſtorms of the winter. 'Cum nives inſtar collium terræ ſuperficiem ubique cooperiunt, ramoſque arborum diutiùs deprimunt & condenſant, certos fructus betulæ arboris----------in formâ longi piperis vorant, & glutiunt indigeſtos; idque tanta aviditate, ac quantitate, ut repletum guttur toto corpore majus appareat. Deinde partitis agminibus 'ſeſe crags on high (of which God himſelf hath given an inſtance in the Eagle, *Job* xxxix. 27, 28.) And ſo among the inſect and reptile kinds, if ſome repoſite their eggs or young in the earth, ſome in wood, ſome in ſtone, ſome on one kind of plant, ſome on another, ſome in warm and dry places, ſome in the water, and moiſt places, and ſome in their own bodies only, as ſhall be ſhewn in proper place ; in all theſe caſes it is, in all probability, the beſt or only method the animal can take for the hatching and production of its young, for their ſupplies, ſafety, or ſome other main point of their being or well-being. This is manifeſt enough in many caſes, and therefore probable in all. It is manifeſt that ſuch animals, for inſtance, as breed in the waters (as not only fiſh, but divers inſects, and other land-animals do) that their young cannot be hatched, fed, or nurſed up in any other element. It is manifeſt alſo, that inſects, which lay their eggs on this, and that, and the other agreeable tree, or plant, or in fleſh,

'ſeſe inter medios nivium colles immergunt, præſertim in Jan. Febr. Martio, quando nives ut turbines, typhones, vel tempeſtates graviſſimæ è nubibus deſcendunt. Cùmque coopertæ ſunt,--- certis hebdomadis cibo in gutture collecto, egeſto, & reſumpto vivunt, venatorum canibus non produntur.-------Quod ſi præſentiunt nivem imminere majorem, prædicto fructu iterum devorato, aliud domicilium captant, in eoque manent uſque ad finem Martii, &c.' Ol. Mag. *hiſt. l.* 19. *c.* 33.

fleſh, &c. that it is by that means their young are fed and nurſed up. And it is little to be doubted alſo, but that theſe matrixes may much conduce to the maturation and production of the young. And ſo in all other the like caſes of nidification, of heat or cold, wet or dry, expoſed or open, in all probability this is the beſt method for the animal's good, moſt ſalutary and agreeable to its nature, moſt for its fecundity, and the continuance and increaſe of its ſpecies; to which every ſpecies of animals is naturally prompt and inclined.

Thus admirable is the natural ſagacity and inſtinct (*b*) of the irrational animals in the convenience and method of their habitations: And no leſs is it in the fabrick of them. Their architectonick ſkill, exerted in the curioſity and

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(*b*) It is a very odd ſtory (which I rather mention for the reader's diverſion, than for its truth) which Dr. *Lud. de Beaufort* relates: 'Vir fide dignus narravit mihi, quòd cùm ſemel, animi gratiâ, nidum aviculæ ligno obturâſſet, ſeque occultaſſet, cupidus videndi, quid in tali occaſione præſtaret; illa cùm fruſtra ſæpiùs tentâſſet roſtro illud auferre, casûs admodum impatiens, abiit, & poſt aliquod temporis ſpatium reverſa eſt, roſtro gerens plantulam, quâ obturamento applicatâ, paulo poſt, illud veluti telum eripuit tantâ vi, ut diſperſa impetu herbula, occaſionem ipſi, ab aviculâ ejus virtutem diſcendi, præripuerit.' *Coſmog. divina*, § 5. *chap.* 1. Had he told us what the plant was, we might have given better credit to this ſtory.

and dexterity of their works, and exceeding the ſkill of man to imitate; this, I ſay, deſerves as much or more admiration and praiſe, than that of the moſt exquiſite artiſt among men. For with what inimitable art (*i*) do theſe poor untaught creatures lay a parcel of rude and ugly ſticks and ſtraws, moſs and dirt together, and form them into commodious neſts! With what curioſity do they line them within, wind and place every hair, feather, or lock of wool, to guard the tender bodies of themſelves, and their young, and to keep them warm? And with what art and craft do many of them thatch over, and coat their neſts without, to dodge and deceive the eye of ſpectators, as well as to guard and fence againſt the injuries of weather (*k*)? With what pro-

digious

(*i*) Of the ſubtilty of birds in nidification, ſee Plin. *nat. hiſt.* *l.* 10, *c.* 33.

(*k*) Among many inſtances that might be given of this ſubtilty of birds, and other creatures, that of the long-tailed Titmouſe deſerves obſervation, who with great art builds her neſt with moſſes, hair, and the webs of ſpiders, caſt out from them when they take their flight. See *book* viii. *chap.* 5. *note* (*e*), with which the other materials are ſtrongly tied together. Having neatly built, and covered her neſt with theſe materials without, ſhe thatcheth it on the top with the Muſcus arboreus ramoſus, or ſuch like broad, whitiſh moſs, to keep out rain, and to dodge the ſpectator's eye; and within ſhe lineth it with a great number of ſoft feathers, ſo

many,

ligious ſubtilty do ſome foreign birds (*l*), not only plat and weave the fibrous parts of vegeables together, and curiouſly tunnel them, nd commodiouſly form them into neſts, but lſo artificially ſuſpend them on the tender wigs of trees, to keep them out of the reach of rapacious animals?

And ſo for inſects, thoſe little, weak, thoſe tender creatures; yet, what admirable artiſts are they in this buſineſs of nidification! with what great diligence doth the little bee gather its

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many, that I confeſs I could not but admire how ſo ſmall a room could hold them; eſpecially that they could be laid ſo cloſe and handſomely together, to afford ſufficient room for a bird with ſo long a tail, and ſo numerous an iſſue as this bird commonly hath, which Mr. *Ray* ſaith, (*Synopſ. method. avium, p.* 74.) ‘Ova inter omnes aviculas numeroſiſſima ‘ponit.’ See more of the neſt of this bird, from Aldrovand. *in Wilugh. Ornith. p.* 243.

(*l*) The neſt of the Guira tangeima, the Icterus minor, and the Jupujuba, or whatever other name the American Hang-neſts may be called by, are of this kind. Of which ſee Willughby's *Ornith. lib.* 2. *chap.* 5. § 12, 13. alſo Dr. Grew's *Muſæum Reg. Soc. part* I. § 4. *chap.* 4. Theſe neſts I have divers times ſeen, particularly in great perfection in our R. S. repoſitory, and in the noble and well-furniſhed Muſæum of my often commended friend Sir *Hans Sloane*; and at the ſame time I could not but admire at the neat mechaniſm of them, and the ſagacity of the bird, in hanging them on the twigs of trees, to ſecure their eggs and young from the apes.

its combs from various trees (*m*) and flowers! the waſp from ſolid (*n*) timber! and with what prodigious geometrical ſubtilty do thoſe little animals work their deep hexagonal cells, the only proper figure that the beſt mathematician could chuſe for ſuch a combination of houſes (*o*)! with what accuracy do other inſects

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(*m*) I mention trees, becauſe I have ſeen bees gather the gum of fir-trees, which at the ſame time gave me the pleaſure of ſeeing their way of loading their thighs therewith, performed with great art and dexterity.

(*n*) Waſps, at their firſt coming, may be obſerv'd to frequent poſts, boards, and other wood that is dry and ſound; but never any that is rotten. Theſe they may he heard to ſcrape and gnaw; and what they ſo gnaw off, they heap cloſe together between their chin and fore-legs, until they have gotten enough for a burden, which they then carry away in their mouths, and make their cells with.

(*o*) Circular cells would have been the moſt capacious; but this would by no means have been a convenient figure, by reaſon much of the room would have been taken up by vacancies between the circles; therefore it was neceſſary to make uſe of ſome of the rectilinear figures. Among which only three could be of uſe; of which *Pappus Alexandrin.* thus diſcourſeth; 'Cum igitur tres figuræ 'ſunt, quæ per ſeipſas locum circa idem punctum 'conſiſtentem replere poſſunt, triangulum ſcil. 'quadratum, & hexagonum, apes illam, quæ ex 'pluribus angulis conſtat, ſapienter delegerunt, 'utpote ſuſpicantes eam plus mellis capere quàm 'utramvis reliquarum. At apes quidem illud tan-

'tum

ſects perforate the earth (*p*), wood, yea, ſtone itſelf (*q*)! for which ſervice, the compleat apparatus of their mouths (*r*), and feet (*s*), deſerves

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‘ tùm quod ipſis utile eſt cognoſcunt; viz. Hexa-‘ gonum quadrato & triangulo eſſe majus, & plus ‘ mellis capere poſſe; nimirùm æquali materiâ in ‘ conſtructionem uniuſcujuſque conſumptâ. Nos ‘ verò qui plus ſapientiæ quàm apes habere profi-‘ temur, aliquid etiam magis inſigne inveſtigabimus.’ *Collect. math. l.* 5.

(*p*) See before, *note* (*c*).

(*q*) See *chap.* 11. *note* (*x*).

(*r*) See *chap.* 11. *note* (*y*).

(*s*) Among many examples, the legs and feet of the Mole Cricket (*Gryllotalpa*) are very remarkable. The fore-legs are very brawny and ſtrong; and the feet armed each with four flat ſtrong claws, together with a ſmall lamina, with two larger claws, and a third with two little claws: which lamina is jointed to the bottom of the foot, to be extended, to make the foot wider, or withdrawn within the foot. Theſe feet are placed to ſcratch ſomewhat ſideways, as well as downward, after the manner of Moles feet; and they are very like them alſo in figure.

Somewhat of this nature, *Swammerdam* obſerves of the worms of the Ephemeron. ‘ To this pur-‘ poſe [to dig their cells] the wiſe Creator hath fur-‘ niſh’d them (ſaith he) with fit members. For, ‘ beſides that their two fore-legs are formed ſome-‘ what like thoſe of the ordinary Moles, or Gryllo-‘ talpa; he hath alſo furniſh’d them with two ‘ toothy cheeks, ſomewhat like the ſheers of Lob-‘ ſters, which ſerve them more readily to bore the ‘ clay.’ Swammerdam’s *Ephem. vit.* publiſhed by Dr. *Tyſon*, *chap.* 3.

ſerves particular obſervation, as hath been, and will be hereafter obſerv'd. And further yet; with what care and neatneſs do moſt of thoſe little ſagacious animals line thoſe their houſes within, and ſeal them up, and fence them without (*t*)! how artificially will others fold up the leaves of trees and plants (*u*)! others houſe themſelves in ſticks and ſtraws; others glue light and floating bodies together (*w*); and

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(*t*) See the before-cited note (*e*).

(*u*) They are for the moſt part, ſome of the Phalænæ tribe, which inhabit the tunnelled, convolved leaves, that we meet with on vegetables in the ſpring and ſummer. And it is a ſomewhat wonderful artifice, how ſo ſmall and weak a creature, as one of theſe newly-hatch'd maggots (for doubtleſs it is they, not the parent-animal, becauſe ſhe emits no web, nor hath any textrine art) can be able to convolve the ſtubborn leaf, and then bind it in that neat round form, with the thread or web it weaves from its own body; with which it commonly lines the convolved leaf, and ſtops up the two ends, to prevent its own falling out, and Earwigs, and other noxious animals getting in.

(*w*) The ſeveral ſorts of Phryganea or Cadews, in their nympha, or maggot-ſtate, thus houſe themſelves; one ſort in ſtraws, call'd from thence Straw-worms; others in two or more ſticks, laid parallel to one another, creeping at the bottom of brooks; others with a ſmall bundle of pieces of ruſhes, duck-weed, ſticks, &c. glu'd together, wherewith they float on the top, and can row themſelves therein about the waters, with the help of their feet: Both theſe are call'd Cod-bait. Divers other ſorts there are, and by that artifice make themſelves floating houſes in the waters, to tranſport themſelves at pleaſure after their food, or other neceſſary occaſions of life! And for a cloſe, let us take the ſcriptural inſtance of the ſpider, *Prov.* xxx. 28. which is one of the four little things, which, *ver.* 24. Agur ſays, is exceeding wiſe: ‘The ſpider taketh hold with her hands, and ‘is in king's palaces (*x*). I will not diſpute the

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are, which the reader may ſee a ſummary of, from Mr. *Willughby*, in *Raii method. inſect. p.* 12. together with a good, tho' very brief deſcription of the papilionaceous fly, that comes from the Codbait Cadew. It is a notable architectonick faculty which all the variety of theſe animals have, to gather ſuch bodies as are fitteſt for their purpoſe, and then to glue them together; ſome to be heavier than water, that the animal may remain at the bottom, where its food is (for which purpoſe they uſe ſtones, together with ſticks, ruſhes, &c.) and ſome to be lighter than water, to float on the top, and gather its food from thence. Theſe little houſes look coarſe, and ſhew no great artifice outwardly; but are well tunnelled, and made within with a hard tough paſte; into which the hinder part of the maggot is ſo fix'd, that it can draw its cell after it any where, without danger of leaving it behind; as alſo thruſt its body out, to reach what it wanteth; or withdraw it into its cell, to guard it againſt harms.

(*x*) Having mentioned the Spider, I ſhall take this occaſion (although it be out of the way) to give an inſtance of the poiſon of ſome of them. Scaliger, *exerc.* 186. relates, ‘That in *Gaſcony*, his counthe truth of our Engliſh tranſlation of this text, but ſuppoſing the animal mention'd to be that which is meant, it is manifeſt that the art of that ſpecies of creatures, in ſpinning their various webs, and the furniture their bodies afford to that purpoſe, are an excellent inſtinct, and proviſion of nature, ſetting forth its glorious author.

And

'try, there are Spiders of that virulency, that if a 'man treads upon them to cruſh them, their poi'ſon will paſs through the very ſoles of his ſhoe.' Boyl. *Subtil. of effluv.* c. 4.

Mr. *Leewenhoek* put a Frog and a Spider together into a glaſs, and having made the Spider ſting the Frog divers times, the Frog dy'd in about an hour's time. *Philoſ. Tranſact.* N° 272.

In the ſame tranſaction, is a curious account of the manner how Spiders lay, and guard their eggs; *viz.* they emit them not out of the hindermoſt part of the body, but under the upper part of her belly, near the hind legs, &c. Alſo there is an account of the parts from which they emit their webs, and divers other things worth obſervation, with cuts illuſtrating the whole.

But in *Philoſ. Tranſ.* N° 22. Dr. *Nath. Fairfax,* from *S. Redi,* and his own obſervations, think Spiders not venomous; ſeveral perſons, as well as birds, ſwallowing them without hurt: which I myſelf have known in a perſon of learning, who was adviſed to take them medicinally at firſt, and would at any time ſwallow them, affirming them to be ſweet, and well-taſted: and not only innocuous, but they are very ſalutiferous too, in ſome of the moſt ſtubborn diſeaſes, if the pleaſant ſtory in

Mouffet

And now from this ſhort and tranſient view of the architectonick faculty of animals, eſpecially the irrationals, we may eaſily perceive ſome ſuperior and wiſe being was certainly concern'd in their creation or original. For, how is it poſſible that an irrational creature ſhould, with ordinary and coarſe, or indeed any materials, be ever able to perform ſuch works, as exceed even the imitation of a rational creature? how could the bodies of many of them (particularly the laſt mention'd) be furniſh'd with architective materials? how could

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Mouffet be true, of a rich *London* matron, cured of a deſperate tympany, by a certain debauchee, that hearing of her caſe, and that ſhe was given over by the doctors, went to her, pretending to be a phyſician, and confidently affirming he would cure her; which ſhe being willing to believe, agrees with him for ſo much money, one half to be paid down, the other upon cure. Upon which he gives her a Spider, promiſing her cure in three days. Whereupon (not doubting but that he had poiſon'd her, and fearing he might be call'd to account for it) he gets out of town as faſt as he could, But inſtead of being poiſon'd, ſhe ſoon recover'd. After ſome months, the quack gets privately to town, when he thought the buſtle might be over; and enquiring how his patient did, was inform'd of her cure; and thereupon viſiting her, and making an excuſe for his abſence, he received his pay with great applauſe and thanks. Mouff. *Inſect. l.* 2. *c.* 15.

Having ſaid ſo much of Spiders, I might here add their flight: But of this, ſee *book* viii. *chap.* 4. *note* (*e*).

could they ever diſcover them to be in their bodies, or know what uſe to make of them? we muſt therefore neceſſarily conclude, that the irrationals either have reaſon and judgment, not only glimmerings thereof, but ſome of its ſuperior acts, as wiſdom and foreſight, diſcretion, art and care; or elſe, that they are only paſſive in the caſe, and act by inſtinct, or by the reaſon of ſome ſuperior Being imprinted in their nature, or ſome way or other (be it how it will) congenial with them. That they are rational, or excel man in art and wiſdom, none ſurely will be ſo fooliſh as to ſay: and therefore we muſt conclude, that thoſe excellent ends they purſue, and that admirable art they exert, is none of their own, but owing to that infinitely-wiſe and excellent being, of whom it may be ſaid, with reference to the irrational, as well as rational creatures, as it is, *Prov.* ii. 6. 'The Lord giveth wiſdom; 'out of his mouth cometh knowledge and 'underſtanding.'

CHAP. XIV.

Of Animals *Self-preſervation.*

HAVING thus conſider'd the food, cloathing, and houſes of animals; let us in this chapter take a glance of another excellent proviſion the wiſe Creator hath made for the good of the animal world; and that is, s, the methods which all animals naturally ake for their ſelf-preſervation and ſafety. And here it is remarkable (as in the caſes before) that man, who is endow'd with reaſon, s born without armature, and is deſtitute of many powers, which irrational creatures have n a much higher degree than he, by reaſon he can make himſelf arms to defend himſelf, can contrive methods for his own guard and ſafety, can many ways annoy his enemy, and ſtave off the harms of noxious creatures.

But for others, who are deſtitute of this ſuper-eminent faculty, they are ſome way or other provided with ſufficient guard (*a*), proportionate to their place of abode, the dangers they are like to incur there (*b*); and, in a word,

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(*a*) 'Callent in hoc cuncta animalia, ſciuntque 'non ſua modò commoda, verùm & hoſtium adverſa; nôrunt ſua tela, nôrunt occaſiones, parteſque diſſidentium imbelles. In ventre mollis eſt 'tenuiſque cutis crocodilo: ideoque ſe, ut territi, 'mergent delphini, ſubeunteſque alvum ilia ſecant 'ſpinâ.' Plin. *nat. hiſt. l.* 8. *c.* 25.

(*b*) 'Omnibus aptum eſt corpus animæ moribus '& facultatibus: equo fortibus ungulis & jubâ eſt 'ornatum (etenim velox & ſuperbum & generoſum 'eſt animal) leoni autem, utpote animoſo & feroci, 'dentibus & unguibus validum. Ita autem & tauro '& apro; illi enim cornua, huic exerti dentes---- 'cervo autem & lepori (timida enim ſunt animalia) velox corpus, ſed inerme. Timidis enim velocitas, arma audacibus conveniebant---- homini 'autem (ſapiens enim eſt---) manus dedit, inſtru-'mentum

word, to their greateſt occaſions and need of ſecurity. Accordingly, ſome are ſufficiently guarded againſt all common dangers, by their natural cloathing; by their armature of ſhells, or ſuch like hard and impregnable covering of their body (*c*). Others deſtitute of this guard, are

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‘ mentum ad omnes artes neceſſarium, paci non minùs quàm bello idoneum. Non igitur indiguit cornu ſibi innato, cùm meliora cornibus arma manibus, quandocunque volet, poſſit accipere: Etenim enſis & haſta majora ſunt arma, & ad incidendum promptiora----neque cornu, neque ungulæ quicquam niſi cominùs agere poſſunt; hominum verò arma eminùs juxta ac cominùs agunt: telum quidem & ſagitta magis quàm cornua.-----Non igitur eſt nudus, neque inermis----ſed ipſi eſt thorax ferreus, quandocunque libet, omnibus coriis difficilius ſauciatu organum------nec thorax ſolum, ſed & domus, & murus, & turris, &c.’ Galen. *de uſ. part. l.* 1. *c.* 2.

(*c*) Shells deſerve a place in this ſurvey, upon the account of their great variety, the curious and uncouth make of ſome, and the beautiful colours, and pretty ornaments of others; but it would be endleſs to deſcend to particulars. Omitting others, I ſhall therefore only take notice of the Tortoiſe-ſhell, by reaſon a great deal of dexterity appears, even in the ſimplicity of the animal's ſkeleton. For, beſides that the ſhell is a ſtout guard to the body, and affords a ſafe retreat to the head, legs, and tail, which it withdraws within the ſhell upon any danger: Beſides this, I ſay, the ſhell ſupplieth the place of all the bones in the body, except thoſe of the extreme parts, the head and neck, and the four e armed, ſome with horns (*d*), ſome with arp quills and prickles (*e*), ſome with claws, me with ſtings (*f*); ſome can ſhift and change

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ur legs and tail. So that at firſt ſight, it is ſome-hat ſurprizing to ſee a compleat ſkeleton conſiſting ſo ſmall a number of bones, and they abundantly fficient for the creatures uſe.

(*d*) *Dentes timentur apri: defendunt cornua tauros:*
Imbelles damæ quid niſi præda ſumus?
Martial. l. 13. Epigr. 94.

(*e*) The Hedge-hog being an helpleſs, ſlow, and atient animal, is accordingly guarded with prickles, d a power of rolling itſelf up in them. ‘Clavis terebrari ſibi pedes, & diſcindi viſcera patientiſſimè ferebat, omnes cultri ictus ſine gemitu pluſquam Spartana nobilitate concoquens.’ Borri- ius *in Blaſ. de Echino.* ‘Panniculum carnoſum amplexabatur muſculus penè circularis, admirandæ fabricæ, lacinias ſuas ad pedes, caudam, caput, variè exporrigens, cujus miniſterio Echinus ſe ad arbitrium in orbem contrahit.’ *Act. Dan. Blaſio.*

Iſte licèt digitos teſtudine pungat acutâ,
Cortice depoſito mollis Echinus erit.
Mart. *l.* 13. Epigr. 86.

(*f*) The ſting of a Waſp, or Bee, &c. is ſo pretty piece of work, that it is worth taking notice of, far as I have not found others to have ſpoken it. Others have obſerved the ſting to be an hol- w tube, with a bag of ſharp penetrating juices s poiſon) joined to the end of it, within the body the Waſp, which is, in ſtinging, injected into the ſh through the tube. But there are, beſides this, o ſmall, ſharp, bearded ſpears, lying within this tube, change their colours (*g*); ſome can make their eſcape by the help of their wings, and others by the ſwiftneſs of their feet; ſome can ſcreen

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tube, or ſting, as in a ſheath. In a Waſp's ſting, I counted eight beards on the ſide of each ſpear, ſomewhat like the beards of fiſh-hooks. Theſe ſpears in the ſting, or ſheath, lie one with its point a little before that of the other; as is repreſented in *fig.* 21. to be ready (I conceive) to be firſt darted into the fleſh; which being once fixed, by means of its foremoſt beard, the other then ſtrikes in too, and ſo they alternately pierce deeper and deeper, their beards taking more and more hold in the fleſh; after which the ſheath or ſting follows, to convey the poiſon into the wound. Which that it may pierce the better, it is drawn into a point, with a ſmall ſlit a little below that point, for the two ſpears to come out at. By means of this pretty mechaniſm in the ſting, it is, that the ſting when out of the body, and parted from it, is able to pierce and ſting us: And by means of the beards being lodged deep in the fleſh, it comes to paſs that Bees leave their ſtings behind them, when they are diſturbed, before they have time to withdraw their ſpears into their ſcabbard. In *fig.* 21. is repreſented the two ſpears as they lie in the ſting. In *fig.* 22, the two ſpears are repreſented when ſqueez'd out of the ſting, or the ſcabbard; in which latter, *fig. A c b*, is the ſting, *c d*, and *b e*, the two bearded ſpears thruſt out.

(*g*) The Camelion is ſufficiently fam'd on this account. Beſides which, *Pliny* tells us of a beaſt as big as an Ox, called the Tarandus, that when he pleaſeth, aſſumes the colour of an Aſs, and 'Colo-

'rem

themſelves by diving in the waters, others by tinging and diſordering the waters (*b*), can make

‘ rem omnium fruticum, arborum, florum, loco-
‘ rumque reddit, in quibus latet metuens, ideoque
‘ rarò capitur.’ Plin. *l.* 8. *c.* 34.

How true this is, there may be ſome reaſon to doubt; but if any truth be in the ſtory, it may be from the animal's chuſing ſuch company, or places, as are agreeable to its colour: as I have ſeen in divers Caterpillars, and other inſects, who I believe were not able to change their colour, from one colour to another; yet I have conſtantly obſerved, do fix themſelves to ſuch things as are of the ſame colour; by which means they dodge the ſpectator's eye. Thus the Caterpillar that feeds on elder, I have more than once ſeen, ſo cunningly adhering to the ſmall branches of the ſame colour; that it might be eaſily miſtaken for a ſmall ſtick, even by a careful view. So a large green Caterpillar, that feeds on buckthorn, and divers others. To which I may add, the prodigious ſagacity of the Ichneumon Flies, that make the kermes (for of that tribe all the kermes I ever ſaw were) how artificially they not only incloſe their eggs within that gummy ſkin, or ſhell, but alſo ſo well humour the colour of the wood they adhere to, by various ſtreaks and colours, that it is not eaſy to diſtinguiſh them from the wood itſelf.

(*b*) ‘ Contra metum & vim, ſuis ſe armis quæque
‘ defendit. Cornibus tauri, apri dentibus, morſu
‘ leones, aliæ fugâ ſe, aliæ occultatione tutantur:
‘ atramenti effuſione ſepiæ, torpore torpedines.
‘ Multæ etiam inſectantes odoris intolerabili fœdi-
‘ tate depellunt.’ Cic. *de nat. deor. l.* 2. *c.* 50.

make their eſcape; and ſome can guard their bodies, even in the very flames, by the ejection of the juice of their bodies (*i*); and ſome by their accurate ſmell, ſight, or hearing, can foreſee dangers (*k*); others by their natural craft, can prevent or eſcape them (*l*); others by their uncouth noiſe (*m*); by the horrid aſpect, and ugly geſticulations of their body (*n*); and

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(*i*) A knight, call'd *Corvini*, at *Rome*, caſt a Salamander into the fire, which preſently ſwell'd, and then vomited ſtore of thick ſlimy matter, which put out the coals; to which the Salamander preſently retired, putting them out again in the ſame manner, as ſoon as they re-kindled, and by this means ſaved itſelf from the force of the fire, for the ſpace of two hours; after which it lived nine months. *Vide Phil. Tranſ.* N° 21. in Lowth, *Abridg. vol.* II. *p.* 816.

(*k*) *Pliny* gives an inſtance in each, *l.* 10. *c.* 69. 'Aquilæ clariùs cernunt [quâm homines]; vultures ſagaciùs odorantur: liquidiùs audiunt talpæ obrutæ terrâ, tam denſo atque ſurdo naturæ elemento.'

(*l*) The doublings of the Hare, before ſhe goes to form, thereby to dodge and deceive the dogs, altho' a vulgar obſervation, is a notable inſtinct for an animal, leſs fam'd for cunning than the Fox, and ſome others.

(*m*) It is natural for many quadrupeds, birds, and ſerpents, not only to put on a torvous angry aſpect, when in danger, but alſo to ſnarl, hiſs, or by ſome other noiſe deter their adverſary.

(*n*) The Iynx, or Wry-neck, although a bird of very beautiful feathers, and conſequently far enough off and ſome even by the power of their excrements, and their ſtink (*o*), can annoy their enemy,

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off from being any way terrible; yet, being in danger, hath ſuch odd contortions of its neck, and motions of its head, that I remember have ſcar'd me, when I was a boy, from taking their neſts, or touching the bird, daring no more to venture my hand into their holes, than if a ſerpent had lodged in it.

(*o*) ‘ Bonaſus tuetur ſe calcibus & ſtercore, quod ‘ ab ſe quaternis paſſibus [trium jugerum longitu‘ dine,’ Plin. *nat. hiſt. l.* 8. *c.* 15.] ‘ ejaculatur, ‘ quod ſæpe comburit adeò ut deglabrentur canes.’ Ray's *Synopſ. quadr. p.* 71.

‘ Camelus Peruvianus clama dictus neminem of‘ fendit, ſed miro admodum ingenio ſe ab illatâ ‘ vindicat injuriâ, nimirum vomitu vel cibi, vel ‘ humoris in vexantem retrorſum cum impetu eja‘ culato, ob protenſam colli longitudinem.’ *Id. ib. p.* 146.

‘ Tzquiepatl, (Anglicè Squnck, Præf. and one ‘ that I ſaw they call'd a Stonck) cùm quis eam in‘ ſectatur, fundit cum ventris crepitu halitum fœti‘ diſſimum: quin ipſa tota teterrimum exhalat odo‘ rem, & urina ſtercuſque eſt fœtidiſſimum, atque ‘ adeò peſtilens, ut nihil ſit reperire in noſtro orbe, ‘ cui in hâc re poſſit comparari: quo ſit, ut in pe‘ riculo conſtituta, urinam & fæces ad 8 pluriumve ‘ paſſuum intervallum ejiciat, hoc modo ſe ab om‘ nibus vindicans injuriis, ac veſtes inficiens macu‘ lis luteis indelebilibus, & nunquam ſatis perſpi‘ rante odore: aliàs innoxium animal eduleque, ‘ hâc ſolâ ratione horrendiſſimum.’ *Id. ib. p.* 182.

enemy, and ſecure themſelves; and againſt ſome (*p*), the divine providence itſelf hath provided a guard.

By ſuch ſhifts and means as theſe, a ſufficient guard is miniſtred to every ſpecies of animals, in its proper reſpective place; abundantly enough to ſecure the ſpecies from deſtruction, and to keep up that balance, which I have formerly ſhew'd, is in the world, among every, and all the ſpecies of animals; but yet not enough to ſecure individuals from becoming a prey to man, or to other creatures, as their neceſſities of life require. To which purpoſe, the natural ſagacity and craft of one intrapping (*q*), and captivating, being in ſome meaſure

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'Si accipiter ardeam in ſublimi moleſtat, ſtercore immiſſo in pennas ejus, eas putreſcere facit: uti ſolinus ſcribit de bonaſo, &c. Ita & lupus urinam ſpargit in perſequentem.' Ol. Mag. *hiſt. l.* 19. *c.* 14.

(*p*) Thus againſt the Crocodile, which can catch its prey only before it, not on one ſide. So the Shark, of which take my often-commended friend Sir *Hans Sloane*'s obſervation; 'It hath this peculiar to it, with ſome others of its own tribe, that the mouth is in its under part, ſo that it muſt turn the belly upwards to prey. And was it not for that time it is in turning, in which the purſued fiſhes eſcape, there would be nothing that could avoid it; for it is very quick in ſwimming, and hath a vaſt ſtrength, with the largeſt ſwallow of any fiſh, and is very devouring.' Sloane's *voyage to Jamaica, p.* 23.

(*q*) See *chap.* xi. *note* (*iii*).

meaſure equivalent to that of the other in evading, is as excellent a means for the maintaining the one, as preſerving the other; and, if well conſider'd, argues the contrivance of the infinitely wiſe Creator and preſerver of the world.

CHAP. XV.

Of the Generation of Animals.

THERE remains now only one thing more of the ten things in common to animals, and that is what relates to their generation (*a*), and conſervation of their ſpecies

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(*a*) Spontaneous Generation, is a doctrine ſo generally exploded, that I ſhall not undertake the diſproof of it. It is evident, that all animals, yea, vegetables too, owe their production to parent-animals and vegetables; that I have often admir'd at the ſloth and prejudices of the ancient philoſophers, in ſo eaſily taking upon truſt the Ariſtotelian, or rather, the Egyptian doctrine of equivocal generation; that when they ſaw Flies, Frogs, and Lice, for inſtance, to be male and female, and accordingly to ingender, lay eggs, &c. they could ever imagine any of theſe creatures ſhould be ſpontaneouſly produced, eſpecially in ſo romantick a manner, as in the clouds; as they particularly thought Frogs were, and that they dropp'd down in ſhowers of rain. For an anſwer to this caſe of Frogs, I ſhall refer to a relation of my own, which my my late moſt ingenious and learned friend, the great Mr. *Ray*, requeſted of me, and was pleas'd to publiſh in his laſt edition of his *Wiſdom of God maniſeſted*, &c. *p.* 365.

But ſome will yet aſſert the raining of Frogs; among which the curious Dr. *Plot* is ſomewhat of this opinion; telling us of the Frogs found on the leads of the lord *Aſton*'s gate-houſe, at *Tixal* in *Staffordſhire*, which he thinks by ſome ſuch means came there; as alſo on the bowling-green, frequently after a ſhower of rain. Plot'*s hiſt. Staff. c.* 1. § 47.

But we may take a judgment of this, and an hundred ſuch like reports, to be met with in conſiderable authors, from other the like reports that have been better enquired into. In a ſcarcity in *Sileſia*, a mighty rumour was ſpread of its raining millet-ſeed; but the matter being enquired into, 'twas found to be only the ſeeds of the ivy-leaved Speed-well, or ſmall Henbit, growing in the place in great plenty. *Eph. Germ. an.* 3. *obſ.* 40. So in the *Archipelago*, it was thought aſhes were rain'd, ſhips being cover'd therewith at a hundred leagues diſtance; but, in all probability, it was from an eruption of *Veſuvius*, that then happen'd. About *Warminſter* in *Wilts*, 'twas reported it rain'd Wheat; but a curious obſerver, Mr. *Cole*, found it to be only Ivy-berries, blown thither in a conſiderable quantity by a tempeſt. In the year 1696, at *Cranſtead* near *Wrotham* in *Kent*, a paſture-field was overſpread with little young Whitings, ſuppoſed to fall from the clouds, in a tempeſt of thunder and rain; but doubtleſs they were brought hither with waters from the ſea by the tempeſt. See the before-commended Mr. Lowth. *Abridg. Philoſ. Tranſ. vol.* II. *p.* 143, 144.

Neither needeth it ſeem ſtrange, that Aſhes, Ivy-berries, ſmall fiſhes, or young Frogs (which yet may have ſome other conveyance) ſhould be thus tranſported by tempeſtuous winds, conſidering to what diſtance, and in what quantities, the ſea-waters were carry'd by the great ſtorm, *Novemb.* 26. 1703. of which an ingenious friend ſent me theſe accounts from *Lewes* in *Suſſex*; viz. 'That a phyſician travelling ſoon after the ſtorm, to *Tiſeburſt*, twenty miles from the ſea, as he rode along pluck'd ſome tops of hedges, and chewing them, found them ſalt: That ſome grapes hanging on the vines at *Lewes*, were ſo too: That Mr. *Williamſon*, rector of *Ripe*, found the twigs in his garden ſalt the *Monday* after the ſtorm; and others obſerved the ſame a week after. That the graſs of the downs about *Lewes*, was ſo ſalt, that the ſheep would not feed till hunger compell'd them: And that the Miller of *Berwick*, (three miles from the ſea) attempting with his man to ſecure his mill, were ſo waſhed with flaſhes of ſea-water, like the breaking of waves againſt the rocks, that they were almoſt ſtrangled therewith, and forced to give over their attempt.'

I call'd the doctrine of equivocal generation, an Egyptian doctrine, becauſe probably it had its riſe in *Egypt*, to ſolve the hypotheſis of the production of men, and other animals, out of the earth, by the help of the ſun's heat. To prove which, the Egyptians (as *Diod. Sicul.* ſaith) produce this obſervation, 'That about *Thebes*, when the earth is moiſtened by the *Nile*, by the intenſe heat of the ſun, an innumerable number of Mice do ſpring out.' From whence he infers, that all kinds of animals might as well at firſt come likewiſe out of the earth. And from theſe the learned Biſhop *Stillingfleet* thinks other writers, as *Ovid*, *Mela*, *Pliny*, &c. have, without examining its truth, taken cies (*b*), by that means. It would not be ſeemly to advance far in this admirable work of God; neither ſhall I at all inſiſt upon that of man, for the ſame reaſon. And as for the irrationals (*c*), I ſhall confine myſelf to theſe five matters.

I. Their

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taken up the ſame hypotheſis. *Vide* Stillingfleet's *Orig. ſacr. part* II. *book* i. *chap.* 1.

The before-commended Dr. *Harris*, from the obſervations of Dr. *Harvey*, *S. Malpighi*, Dr. *de Graaf*, and Mr. *Leewenhoek* infers three things concerning generation, as highly probable; '1. That animals ' are *ex animalculo*. 2. That the animalcules are ' originally *in ſemine marium, & non in fœminis*, ' 3. That they can never come forward, or be ' formed into animals of the reſpective kind, without the *ova in fœminis*.' His proofs and illuſtrations, ſee under the word generation, in his *Lex. Tech. vol.* II.

(*b*) ' At certè natura, ſi fieri potuiſſet, maximè ' optâſſet ſuum opificium eſſe immortale: quod ' cùm per materiam non liceret (nam quod-----ex ' carne eſt compoſitum, incorruptibile eſſe non poteſt) ſubſidium quod potuit ipſi ad immortalitatem eſt fabricata, ſapientis cujuſdam urbis conditoris exemplo, &c. Nam mirabilem quandam ' rationem invenit, quomodo in demortui animalis ' locum, novum aliud ſufficiat.' Galen. *de uſu part. l.* 14. *c.* 22.

(*c*) ' Animantia bruta obſtetricibus non indigent in edendo partu, cùm inditâ naturæ vi umbilicus ſeipſum occludat.' Ol. Rudbeck *in Blaſii anat. felis*.

I. Their natural ſagacity in chuſing the fitteſt places to repoſite their eggs and young.

II. The fitteſt times and ſeaſons they make uſe of for their generation.

III. The due and ſtated number of their young.

IV. Their diligence and earneſt concern in their breeding up.

V. Their faculty of feeding them, and their art and ſagacity exerted therein.

I. The natural ſagacity of irrational animals, in chuſing the fitteſt places to repoſite their eggs and young. Of this I have given larger hints already than I needed to have done, when I ſpake of the architecture (*d*) of animals, intending then to have wholly paſſed by this buſineſs of generation: I ſhall therefore now only ſuperadd a few other inſtances, the more to illuſtrate this matter.

It hath been already ſhewn, and will hereafter (*e*) farther appear, that the places in which the ſeveral ſpecies of animals lay up their eggs, and young, are the beſt for that purpoſe; waters (*f*) for one; fleſh for another;

(*d*) *Chap.* 13.

(*e*) *Book* viii. *chap.* 6.

(*f*) The Ephemeron, as it is an unuſual and ſpecial inſtance of the brevity of life, ſo I take it to be a wonderful inſtance of the ſpecial care and providence of God, in the conſervation of the ſpecies of that animal. For, 1. As an animal, whoſe life is determined ther; holes in wood (*g*), earth, or ſtone (*h*), for others; and neſts for others; and we ſhall find, that ſo ardent is the propenſity of all animals, even of the meaneſt inſects, to get a fit place for the propagation of their young, that, as will hereafter appear, there is ſcarce any thing that eſcapeth the inqueſt of thoſe little ſubtle creatures. But beſides all this, there are two or three things more obſervable, which plainly argue the inſtinct of ſome ſuperior rational being. As,

1. The

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determined in about five or ſix hours time (viz. from about ſix in the evening, till about eleven o'clock at night) needs no food; ſo neither doth the Ephemeron eat, after it is become a Fly. 2. As to its generation; in thoſe five hours of its life, it performs that, and all other neceſſary offices of life: For in the beginning of its life, it ſheds its coat; and that being done, and the poor little animal thereby render'd light and agile, it ſpends the reſt of his ſhort time in friſking over the waters, and at the ſame time the female droppeth her eggs on the waters, and the male his ſperm on them, to impregnate them. Theſe eggs are ſpread about by the waters; deſcend to the bottom by their own gravity; and are hatched by the warmth of the ſun, into little worms, which make themſelves caſes in the clay, and feed on the ſame without any need of parental care. *Vide Ephem. vita*, tranſlated by Dr. *Tyſon* from *Swammerdam*. See alſo *book* viii. *chap*. 6. *note* (*r*).

(*g*) See *chap*. 13. *note* (*c*), and book viii. *chap*. 6.

(*h*) The Worms in *chap*. 11. *note* (*x*), breed in the holes they gnaw in ſtone, as is manifeſt from their eggs found therein.

1. The compleat and neat order which any creatures obſerve in laying up their ed, or eggs, in proper repoſitories: Of hich I ſhall ſpeak in another place (*i*).

2. The ſuitable apparatus in every crea- re's body, for the laying up its eggs, ſeed, young, in their proper place. It would as endleſs as needleſs to name all particu- rs, and therefore an inſtance or two of the ſect-tribe, may ſerve for a ſpecimen in this ace, till I come to other particulars. Thus ſects, who have neither feet adapted to ratch, nor noſes to dig, nor can make arti- ial neſts to lay up their young; yet what undant amends is there made them in the wer they have either to extend the abdo- en (*k*), and thereby reach the commodious places

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(*i*) See *book* viii, *chap.* 6. *note* (*q*).

(*k*) Many, if not moſt flies, eſpecially thoſe of e Fleſh-fly kind, have a faculty of extending their ropygia, and thereby are enabled to thruſt their gs into convenient holes, and receptacles for their ung, in fleſh, and whatever elſe they fly-blow; t none more remarkable than the Horſe-fly, cal- d by *Pennius* in *Mouffet* (*p.* 62.) Σκολιοῦρος, i. e. *rvicauda*, and the Whame, or Burrel-fly, which vexatious to horſes in ſummer, not by ſtinging em, but only by their bombylious noiſe, or tick- ng them in ſticking their nits, or eggs, on the ir; which they do in a very dexterous manner, thruſting out their Uropygia, bending them up, d by gentle, ſlight touches, ſticking the eggs to e hair of the legs, ſhoulders, and necks, com- monly places they could not otherwiſe come at; or elſe they have ſome aculeous part or inſtrument to terebrate, and make ways for

monly of horſes; ſo that horſes which go abroad, and are ſeldom dreſſed, are ſomewhat diſcoloured by the numerous nits adhering to their hair.

Having mentioned ſo much of the generation of this inſect, although it be a little out of the way, I hope I ſhall be excuſed for taking notice of the long-tailed maggot, which is the product of theſe nits or eggs, called by Dr. *Plot*, Eruca Glabra [or rather Eula Scabra it ſhould be] Caudata Aquatico-arborea, it being found by him in the water of an hollow tree; but I have found it in ditches, ſaw-pits, holes of water in the high-way, and ſuch-like places where the waters are moſt ſtill and foul. This maggot I mention, as being a ſingular and remarkable work of God, not ſo much for its being ſo utterly unlike as it is to its parent bee-like fly, as for the wiſe proviſion made for it by its long tail; which is ſo jointed at certain diſtances from the body, as that it can be withdrawn, or ſheathed, one part within another, to what length the maggot pleaſeth, ſo as to enable it to reach the bottom of very ſhallow, or deeper waters, as it hath occaſion, for the gathering of food. At the end of this tapering is a ramification of *fibrillæ*, or ſmall hairs, repreſenting, when ſpread, a ſtar; with the help of which, ſpread out on the top of the waters, it is enabled to hang, making, by that means, a ſmall depreſſion or concavity on the ſurface of the water. In the midſt of this ſtar, I imagine the maggot takes in air, there being a perforation, which with a microſcope I could perceive to be open, and by the ſtar to be guarded againſt the incurſion of the water.

for their eggs into the root (*l*), trunk (*m*), fruit,

(*l*) The excreſcences on the root of Cabbages, Turneps, and divers other plants, have always a maggot in them; but what the animal is that thus makes its way to the root under ground, whether Ichneumon, Phalæna, Scarab, or Scolopendra, I could never diſcover, being not able to bring them to any thing in boxes.

(*m*) I preſume there are only of the Ichneumon-fly kind, that have their generation in the trunks of vegetables. In Malpighi *de Gallis*, *fig.* 61. is a good cut of the gouty excreſcences, or rather tumours, of the Briar-ſtalk: From which proceeds a ſmall black Ichneumon-fly, with red legs; black, ſmooth jointed antennæ; pretty large thorax; and ſhort, round belly, in the ſhape of an heart. It leapeth as a Flea. The male (as in other inſects) is leſſer than the female, and very venerous, in ſpite of danger, getting upon the female, whom they beat and tickle with their breeches and horns, to excite them to a Coït.

Another example of the generation in the trunks of vegetables, ſhall be from the papers of my often-commended friend Mr. *Ray*, which are in my hands, and that is an obſervation of the ingenious Dr. *Nathaniel Wood*: ‘I have (ſaid he) lately obſerved many eggs in the common ruſh; one ſort are little tranſparent eggs, in ſhape ſomewhat like a pear, or report, lying within the ſkin, upon, or in the medulla, juſt againſt a browniſh ſpot on the outſide of the ruſh; which is apparently the creatrix of the wound made by the fly, when ſhe puts her eggs there. Another kind is much longer, and not ſo tranſparent, of a long oval, or rather fruit (*n*), leaves (*o*), and the tender buds of vegetables,

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‘ cylindrical form; ſix, eight, or more, lie commonly together, acroſs the ruſh, parallel to each other, like the teeth of a comb, and are as long as the breadth of the ruſh.’ Letter from *Kilkenny* in *Ireland*, *April* the 28th, 1697.

(*n*) See *book* viii. *chap.* 6. *note* (*d*).

(*o*) I have in *chap.* 13. *note* (*u*), and *book* viii. *chap.* 6. *note* (*e*), (*f*), taken notice of the nidification and generation of ſome inſects, on the leaves of vegetables, and ſhall therefore, for the illuſtration of this place, chuſe an uncommon example out of the Scarab-kind (the generation of which tribe hath not been as yet mentioned) and that is, of a ſmall Scarab bred in the very tips of Elm-leaves. Theſe leaves, in ſummer, may be obſerved to be, many of them, dry and dead, as alſo turgid; in which lieth a dirty, whitiſh, rough maggot. From which proceeds a Beetle of the ſmalleſt kind, of a light, weeſel colour, that leapeth like a Graſhopper, although its legs are but ſhort. Its eyes are blackiſh, elytra thin, and prettily furrowed, with many concavities in them; ſmall club-headed antennæ, and a long roſtrum like a proboſcis.

The ſame, or much like this, I have met with on tips of oaken and holly-leaves. How the Scarab lays its eggs in the leaf, whether by terebrating the leaf, or whether the Maggot, when hatched, doth it, I could never ſee. But with great dexterity, it makes its way between the upper and under membranes of the leaf, feeding upon the parenchymous part thereof. Its head is ſlenderer and ſharper than moſt of Maggots, as if made on purpoſe for this work; but yet I have often wondered

at

tables (*p*), or ſome other ſuch curious and ſecure method they are never deſtitute of. To which we may add,

3. The natural poiſon (*q*) (or what can I call it) which many, or moſt of the creatures, laſt intended, have, to cauſe the germination of ſuch balls, caſes, and other commodious repoſitories, as are an admirable lodgment to the eggs and young; that particularly aſſiſt in the incubation and hatching the young, and then afford them ſufficient food and nouriſhment in all their nympha-ſtate, in which they need food; and are afterwards commodious houſes and beds for them in their aurelia-ſtate, till they are able to break priſon, fly abroad, and ſhift for themſelves. But this ſhall be taken notice of, when I come to treat of inſects.

II. As irrational animals chuſe the fitteſt place, ſo alſo the fitteſt times and ſeaſons for their generation. Some indeed are indifferent to all times, but others make uſe of peculiar ſeaſons (*r*). Thoſe, for inſtance, whoſe proviſions

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at their artifice, in ſo nicely ſeparating the membranes of the elm-leaf, without breaking them, and endangering their own tumbling out of them, conſidering how thin, and very tender, the ſkins of that leaf (particularly) are.

(*p*) See *book* viii. *chap.* 6. *note* (*z*).

(*q*) See *book* viii. *chap.* 8. to *note* (*bb*), &c.

(*r*) Πολλὰ δὲ ϗ πρὸς ἐκτροφὰς τῶν τέκνων στοχαζόμενα ποιοῦνται τὸν συνδυασμὸν ἐν τῇ ἀπαρτιζούσῃ ὥρᾳ. Ariſt. *Hiſt. An.* *l.* 5. *c.* 8. ubi plura.

viſions are ready at all ſeaſons, or who are under the tuition of man, produce their young without any great regard to heat or cold, wet or dry, ſummer or winter. But others, whoſe proviſions are peculiar, and only to be met with at certain ſeaſons of the year; or who, by their migration, and change of place, are tied up to certain ſeaſons; theſe, (as if endowed with a natural care and foreſight of what ſhall happen) do accordingly lay, hatch, and nurſe up their young in the moſt proper ſeaſons of all the year for their purpoſe; as in ſpring, or ſummer, the times of plenty of proviſions, the times of warmth for incubation, and the moſt proper ſeaſons to breed up their young, till they are able to ſhift for themſelves, and can range about for food, and ſeek places of retreat and ſafety, by flying long flights as well as their progenitors, and paſſing into far diſtant regions, which (when others fail) afford thoſe helpleſs creatures the neceſſaries of life.

III. To the ſpecial ſeaſons, I may add the peculiar number of young produced by the irrational creatures. Of which I have already taken ſome notice, when I ſpake of the balance of animals (*s*). Now, if there was not a great deal more than chance in this matter, even a wiſe government of the creation, it could never happen that every ſpecies of animals ſhould be tied up to a certain rate and propor-

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(*s*) See *chap.* x.

proportion of its increaſe; the moſt uſeful would not be the moſt fruitful, and the moſt pernicious produce the feweſt young, as I have obſerved it commonly is. Neither would every ſpecies produce ſuch a certain rote as it is only able to breed up: but all would be in a confuſed, huddled ſtate. Inſtead of which, on the contrary, we find every thing in compleat order; the balance of genera, ſpecies and individuals always proportionate and even; the balance of ſexes the ſame; moſt creatures tied up to their due ſtint and number of young, without their own power and choice, and others (particularly of the winged (*t*) kind) producing their due number at choice and pleaſure; ſome large numbers, but not more than they can cover, feed and foſter; others fewer, but as many as they can well nurſe and breed up. Which minds me,

IV. Of

(*t*) Mr. *Ray* alledges good reaſon to conclude, That although birds have not an exact power of numbering, yet, that they have of diſtinguiſhing many from few, and knowing when they come near to a certain number; and that they have it in their power to lay many or few eggs. All which he manifeſteth from Hens, and other domeſtick fowls, laying many more eggs when they are withdrawn, than when not. Which holds in wild as well as domeſtick birds, as appears from Dr. *Liſter*'s experiment in withdrawing a Swallow's egg, which by that means laid nineteen eggs ſucceſſively before ſhe gave over. *Vide* Ray's *Wiſdom of God*, &c. *p.* 137.

IV. Of the diligence and earneſt concern which irrational animals have of the production and breeding up their young. And here I have already taken notice of their Στοργὴ, or natural affection, and with what zeal they feed and defend their young. To which may be added theſe two things:

1. The wonderful inſtinct of incubation. It is utterly impoſſible, that ever unthinking, untaught animals ſhould take to that only method of hatching their young, was it not implanted in their nature by the infinitely wiſe Creator. But ſo ardent is their deſire, ſo unwearied is their patience when they are engaged in that buſineſs, that they will abide in their neſts for ſeveral weeks, deny themſelves the pleaſures, and even the neceſſaries of life; ſome of them even ſtarving themſelves almoſt, rather than hazard their eggs to get food; and others either performing the office by turns (*u*), or elſe the one kindly ſeeking out, and carrying food to the other (*w*), engaged in

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(*u*) ‘Palumbes incubat fœmina poſt meridiana ‘in matutinum, cætero mas. Columbæ incubant ‘ambo, interdiu mas, noctu fœmina.’ Plin. *Nat. hiſt. l.* 10. *c.* 58.

(*w*) Of the common Crow, Mr. *Willugbby* ſaith, ‘The females only ſit, and that diligently, the ‘males in the mean time bring them victuals; as ‘*Ariſtotle* ſaith. In moſt other birds, which pair ‘together, the male and female ſit by turns.’ Ornithol. *l.* 2. § 1. *chap.* 2. § 2. And I have obſerved n the office of incubation. But of theſe matters in a more proper place (*x*).

2. When the young ones are produced, not only with what care do they feed and nurſe them; but with what ſurprizing courage do ll or moſt creatures defend them! It is ſomewhat ſtrange to ſee timid creatures (*y*), who at other times are cowardly, to be full of courage, and undaunted at that time; to ſee them furiouſly and boldly encounter their enemy, inſtead of flying from him; and expoſe themſelves to every danger, rather than hazard and forſake their young.

With this earneſt concern of the irrational nimals for their young, we may join in the

V. And laſt place, Their faculty and ſagacity of feeding them. About which I ſhall take notice of three things.

1. The faculty of ſuckling the young, is an excellent proviſion the Creator hath made for thoſe helpleſs creatures. And here the agreeableneſs

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ſerved the female-crows to be much fatter than the males, in the time of incubation; by reaſon the male, out of his conjugal affection, almoſt ſtarves himſelf, to ſupply the female with plenty.

(*x*) See *book* vii. *chap.* 4.

(*y*) ‘ Volucribus natura novam quandam, pullos educandi, rationem excogitavit: ipſis enim præcipuum quendam amorem in ea quæ procrearent, ingeneravit, quo impulſu bellum pro pullis cum ferocibus animalibus, quæ ante declinârunt, intrepidè ſuſcipiunt, victùmque ipſis convenientem ſuppeditant.’ Galen *de uſ. part. l.* 14. *c.* 4.

ableneſs and ſuitableneſs of that food to young creatures, deſerves particular obſervation; as alſo their delight in it, and deſire and endeavours after it, even as ſoon as born (*z*), together with the willingneſs of all, even the moſt ſavage and fierce animals, to part with it, and to adminiſter it to their young, yea, to teach and inſtitute them in the art of taking it.

And laſtly, to name no more, the curious apparatus which is made for this ſervice in the divers ſpecies of animals, by a due number of breaſts, proportionable to the occaſions of each animal; by curious glands in thoſe breaſts, to ſeparate that nutritive juice, the milk, by arteries and veins to convey it to them, and proper rivulets and channels to convey it from them, with dugs and nipples, placed in the moſt convenient part of the body (*aa*) of each animal,

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(*z*) 'In iis animantibus quæ lacte aluntur, omnis ferè cibus matrum lacteſcere incipit: eaque, quæ paulo antè nata ſunt, ſine magiſtro, duce naturâ, mammas appetunt, earumque ubertate ſaturantur. Atque ut intelligamus nihil horum eſſe fortuitum, & hæc omnia eſſe providæ, ſolertiſque naturæ, quæ multiplices fœtus procreant, ut ſues, ut canes, his mammarum data eſt multitudo; quas eaſdem paucas habent eæ beſtiæ, quæ pauca gignunt.' Cic. *de nat. deor. l.* 2. *c.* 51. *Conſule quoque* Galen. *de uſ. part. l.* 14. *c.* 4. *& l.* 15. *c.* 7.

(*aa*) 'Animalia ſolidipeda, & ruminantia, vel cornigera, inter femora mammas habent, quorum fœtus ſtatim à partu pedibus inſiſtunt, quòd matres inter lactandum non decumbant, ut equa, aſina, nimal, to adminiſter it to their young: All heſe things, I ſay, do manifeſtly proclaim the are and wiſdom of the great Creator.

2. As for ſuch animals as do in another anner breed up their young, by finding out ood, and putting it into their mouth, the rovision made in them for this ſervice, to rike, catch, to pouch and convey their prey nd food to their young (*bb*), is very conſiderable.

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aſina, &c. Animalia digitata & multipara in medio ventre, ſcil. ſpatio ab inguine ad pectus (in cuniculo uſque ad jugulum) duplicem mammarum ſeriem ſortita ſunt, quæ omnia decumbentia ubera fœtibus admovent, ut urſa, leæna, &c. Si verò hæc in ſolo inguine mammas gererent, propria crura inter decumbendum fœtûs acceſſum ad mammas nonnihil præpedirent. Mulieribus mammæ binæ ſunt, ut & papillæ, nimirum ut latus lateri conformiter reſpondeat, & ut alternatim infans à latere in latus inter ſugendum tranferatur, ne corpus ejus uni lateri nimis aſſueſcens quoquo modo incurvetur. Simia, homo ſylveſtris, &c." las. *Anat. animal. part* I. *cap.* 6. *de Cane ex Vhartono.* See here what *Pliny* hath alſo, *lib.* 11. *hap.* 40.

In the Elephant, the nipples are near the breaſt, y reaſon the old one is forced to ſuck herſelf, and y the help of her trunk conveys the milk into the outh of her young. *Vide Phil. Tranſ.* N° 336.

(*bb*) For an exemplification, I might name many nimals, particularly birds, whoſe parts are compleatly ſuited to this ſervice. They are characteriſticks of rapacious birds, to have aduncous bills nd talons to hold and tear; and ſtrong brawny thighs derable. And ſo is alſo their ſagacity in equally diſtributing it among them, that among many, all ſhall be duly, equally, and in good order, fed.

3. There is yet another inſtinct remaining of ſuch animals as can neither adminiſter ſuck to

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thighs to ſtrike and carry their prey; as well as a ſharp piercing ſight to eſpy it afar off. Raii *Synopſ. method. av. p.* 1. The Pelican alſo might be here named, for its prodigious bag under its bill and throat, big enough to contain thirty pints. *Id. ibid. p.* 122. And, to name no more, the common Heron hath its moſt remarkable parts adapted to this ſervice; long legs for wading; and a long neck anſwerable thereto to reach prey; a wide, extenſive throat to pouch it; long toes, with ſtrong hooked talons (one of which is remarkably ſerrate on the edge) the better to hold their prey; a long ſharp bill to ſtrike their prey, and ſerrate towards the point, with ſharp hooked beards ſtanding backward, to hold their prey faſt when ſtruck; and laſtly, large, broad, concave wings (in appearance much too large, heavy, and cumberſome for ſo ſmall a body, but) of great uſe to enable them to carry the greater load to their neſts, at ſeveral miles diſtance; as I have ſeen them do from ſeveral miles beyond me, to a large heronry above three miles diſtant from me. In which I have ſeen Plaiſe, and other fiſh, ſome inches long, lying under the high trees in which they build; and the curious and ingenious owner thereof, *D'Acre Barret*, Eſq; hath ſeen a large Eel conveyed by them, notwithſtanding the great annoyance it gave them in their flight, by its twiſting this way and that way about their bodies.

o their young, neither lay them in places afording food, nor can convey and bring them ood, but do with their eggs, lay up proviions for their future young. Somewhat of his is reported of ſome birds (*cc*); but I have nyſelf, with pleaſure, frequently ſeen ſome f the ſpecies of inſects to carry ample proviions into their dry and barren cells, where hey have ſealed them carefully and cautiouſly p with their eggs, partly, it is like, for inubation-ſake, and partly as an eaſy bed to odge their young; but chiefly, for future rovifion for their young, in their nymphaate, when they ſtand in need of food (*dd*).

(*cc*) This is reported of the American Oſtrich, nentioned by *Acarette*, in *Phil. Tranſ.* N° 89. Of vhich ſee *book* vii. *chap.* 4. *note* (*c*).

(*dd*) Hornets, Waſps, and all the kinds of Bees, rovide honey; and many of the Pſeudoſphecæ, nd Ichneumon Waſps and Flies, carry Maggots, piders, &c. into their neſts; of which ſee above, *hap.* 13. *note* (*c*).

CHAP. XVI.

The CONCLUSION.

THUS I have, as briefly as I well could (and much more briefly than the matters eſerved) diſpatched the decad of things I prooſed in common to the ſenſitive creatures. nd now let us pauſe a little, and reflect. And

And upon the whole matter, what leſs can be concluded, than that there is a Being infinitely wiſe, potent, and kind, who is able to contrive and make this glorious ſcene of things, which I have thus given only a glance of? For what leſs than infinite, could ſtock ſo vaſt a globe with ſuch a noble ſet of animals? all ſo contrived, as to miniſter to one another's help ſome way or other, and moſt of them ſerviceable to man peculiarly, the top of this lower world, and who was made, as it were, on purpoſe to obſerve and ſurvey, and ſet forth the glory of the infinite Creator, manifeſted in his works! Who? what, but the great God, could ſo admirably provide for the whole animal world, every thing ſerviceable to it, or that can be wiſhed for, either to conſerve its ſpecies, or to miniſter to the being or well-being of individuals! particularly, who could feed ſo ſpacious a world, who could pleaſe ſo large a number of palates, or ſuit ſo many palates to ſo great a variety of food, but the infinite conſervator of the world! And who but the ſame great He, could provide ſuch commodious cloathing for every animal; ſuch proper houſes, neſts, and habitations; ſuch ſuitable armature and weapons; ſuch ſubtilty, artifice, and ſagacity, as every creature is more or leſs armed and furniſhed with, to fence off the injuries of the weather, to reſcue itſelf from dangers, to preſerve itſelf from the annoyances of its enemies; and, in a word, to conſerve itſelf, and its ſpecies! What but an infinite ſuperintending power could ſo equally balance the ſeveral ſpecies of animals, and conſerve the numbers of the individuals of every ſpecies ſo even, as not to over or under-people the terraqueous globe! Who, but the infinite wiſe Lord of the world, could allot every creature its moſt ſuitable place to live in, the moſt ſuitable element to breathe, and move, and act in! and who but He, could make ſo admirable a ſet of organs, as thoſe of reſpiration are, both in land and water animals! who could contrive ſo curious a ſet of limbs, joints, bones, muſcles, and nerves, to give to every animal the moſt commodious motion to its ſtate and occaſions! And, to name no more, what anatomiſt, mathematician, workman, yea angel, could contrive and make ſo curious, ſo commodious, and every way ſo exquiſite a ſet of ſenſes, as the five ſenſes of animals are, whoſe organs are ſo dexterouſly contrived, ſo conveniently placed in the body, ſo neatly adjuſted, ſo firmly guarded, and ſo compleatly ſuited to every occaſion, that they plainly ſet forth the agency of the infinite Creator and Conſervator of the world.

So that here, upon a tranſient view of the animal world in general only, we have ſuch a throng of glories, ſuch an enraviſhing ſcene of things, as may excite us to admire, praiſe, and adore the infinitely wiſe, powerful, and kind Creator; to condemn all atheiſtical principles; and with holy David, *Pſal.* xiv. 1. to conclude, That he is in good earneſt a Fool, that dares to ſay, 'There is no God,' when we are every where ſurrounded with ſuch manifeſt characters, and plain demonſtrations of that infinite being.

But in the next Book we ſhall ſtill find greater tokens, if poſſible, when I come to take a view of animals in particular.

A SURVEY *of the particular Tribes of Animals.*

IN the foregoing Book, having taken a view of the things in common to animals, my buſineſs in the next, will be to inſpect the particular tribes, in order to give further manifeſtations of the infinite Creator's wiſdom, power, and goodneſs towards the animal world.

BOOK V.

A Survey of MAN.

THE firſt genus of animals that I ſhall take notice of, ſhall be Man, who may juſtly claim the precedence in our diſcourſe, inaſmuch as God hath given him the ſuperiority

rity in the animal world, *Gen.* i. 26. 'And 'God ſaid, let us make man in our image, 'after our likeneſs, and let them have dominion over the fiſh of the ſea, and over the 'fowl of the air, and over the cattle, and 'over all the earth, and over every creeping 'thing that creepeth upon the earth.'

And as to man, we have ſo excellent a piece of workmanſhip, ſuch a microcoſm, ſuch an abridgment of the Creator's art in him, as is alone ſufficient to demonſtrate the being and attributes of God. Which will appear, by conſidering the ſoul and the body of man.

CHAP. I.

Of the Soul of Man.

MY ſurvey of man I ſhall begin with the ſoul of man, by reaſon it is his moſt noble part (*a*), the copy of the divine image in us (*b*), in which we have enough to fill us with

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(*a*) 'Jam verò animum ipſum, mentemque hominis, rationem, conſilium, prudentiam, qui non 'divinâ curâ perfecta eſſe perſpicit, is his ipſis re'bus mihi videtur carere.' Cic. *de nat. deor. l.* 2. *c.* 59.

(*b*) *Senſum à cæleſti demiſſum traximus arce,*
Cujus egent prona, & terram ſpectantia: mundi
Principio indulſit communis conditor illis
Tantùm animas; nobis animum quoque.
Juven. Sat. xv. ver. 144.

with admiration of the munificence, power, and wiſdom of the infinite Creator (*c*), when we contemplate the noble faculties of this our ſuperior part, the vaſt reach and compaſs of its underſtanding, the prodigious quickneſs and piercingneſs of its thought, the admirable ſubtilty of its invention, the commanding power of its wiſdom, the great depth of its memory (*d*), and, in a word, its divine nature and operations. But

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Et cùm non aliter poſſent mortalia fingi,
Adjunxit geminas, illæ cum corpore lapſæ
Intereunt: hæc ſola manet, buſtoque ſuperſtes
Evolat. Claud. de 4. Conſul. Hon.

(*c*) ' Nam ſiquis nulli ſectæ addictus, ſed liberâ ' ſententiâ rerum conſiderationem inierit, conſpicatus in tantâ carnium ac ſuccorum collovie tantam ' mentem habitare; conſpicatus item & cujuſvis ' animalis conſtructionem (omnia enim declarant ' opificis ſapientiam) mentis, quæ homini ineſt, ' excellentiam intelliget, tum opus de partium utilitate, quod prius exiguum eſſe ſibi videbatur, ' perfectiſſimæ theologiæ verum principium conſtituet: quæ theologia multò eſt major atque præſtantior totâ medicinâ.' Galen *de uſu part. l.* 17. *c.* 1.

(*d*) Among many examples that I could give of perſons famous for memory, *Seneca*'s account of himſelf may be one; ' Hanc [memoriam] aliquando ' in me floruiſſe, ut non tantùm ad uſum ſufficeret, ' ſed in miraculum uſque procederet, non nego. ' Nam & 2000 nominum recitata, quo ordine erant ' dicta, reddebam: & ab his qui ad audiendum ' præceptorem noſtrum convenerunt, ſingulos verſus à ſingulis datos, cùm plures quàm 200 effice-

' rentur,

But I ſhall not dwell on this, though the ſuperior part of man, becauſe it is the leaſt known. Only there are two things I cannot eaſily paſs by, becauſe they manifeſt the eſpecial concurrence and deſign of the infinitely wiſe Creator, as having a particular and neceſſary tendency to the management and good order of the world's affairs. The

Iſt. Of which is the various genii, or inclinations of men's minds to this, and that, and the other buſineſs (*e*). We ſee how naturally
men

‘rentur, ab ultimo incipiens uſque ad primum recitabam.’ After which, mention is made of the great memory of *Latro Porcius* (*chariſſimi mihi ſodalis*, *Seneca* calls him) who retained in his memory all the declamations he had ever ſpoken, and never had his memory fail him, not ſo much as in one ſingle word. Alſo he takes notice of *Cyneas*, ambaſſador to the *Romans* from king *Pyrrhus*, who in one day had ſo well learned the names of his ſpectators, that ‘poſtero die novus homo & ſenatum, & omnem urbanam circumfuſam ſenatu plebem, nominibus ſuis perſalutavit.’ Senec. *controverſ. l.* 1. *init. Vid. quoque* Plin. *l.* 7. *c.* 24. where he alſo adds other examples; viz. ‘Cyrus rex omnibus in exercitu ſuo militibus nomina reddidit; L. Scipio populo Rom. Mithridates 22 gentium rex, totidem linguis jura dedit, pro concione ſingulas ſine interprete affatus. Charmidas (ſeu potiùs Carneades)-----quæ quis exegerat volumina in bibliothecis, legentis modo repræſentavit.’

(*e*) *Diverſis etenim gaudet natura miniſtris,*
Ut fieri diverſa queant ornantia terras.
Nec patitur cunctos ad eandem currere metam,

Sed

men betake themſelves to this and that employment: ſome delight moſt in learning and books, ſome in divinity, ſome in phyſick, anatomy, and botany, ſome in critical learning, and philology, ſome in mathematicks, ſome in metaphyſicks, and deep reſearches; and ſome have their delight chiefly in mechanicks, architecture, war, navigation, commerce, agriculture; and ſome have their inclinations lie even to the ſervile offices of the world, and an hundred things beſides.

Now all this is an admirably wiſe, as well as moſt neceſſary proviſion, for the eaſy and ſure tranſacting the world's affairs; to anſwer every end and occaſion of man; yea, to make man helpful to the poor helpleſs beaſts, as far as his help is needful to them; and all without any great trouble, fatigue, or great inconvenience to man; rather as a pleaſure and diverſion to him. For ſo far it is from being a toil, that the greateſt labours (*f*), cares, yea,

and

Sed varias jubet ire vias, varioſque labores
Suſcipere, ut vario cultu ſit pulchrior orbis.

Paling. in Scorp.

Οὕτως οὐ πάντεσσι Θεὸς χαρίεντα δίδωσι
Ἀνδράσιν, &c.

'Ita non omnibus hominibus ſua dona dat Deus, 'neque bonam indolem, neque prudentiam, nec 'eloquentiam: alius namque vultum habet deformem; ſed Deus formam eloquentiâ ornat, &c.' Hom. *Odyſ.* The like alſo in *Iliad. l.* 13.

(*f*) Altho' *Solomon* declares, *Eccleſ.* xii. 12. 'That much ſtudy is a wearineſs to the fleſh,'

yet

nd dangers too, become pleaſant to him who purſuing his genius, and whoſe ardour of nclination eggs him forward, and buoys him p under all oppoſition, and carrieth him hro' every obſtacle, to the end of his deſigns nd deſires.

II. The next is, the inventive power of the ſoul (*g*). Under which I might ſpeak of many things; but I ſhall take notice only of two, becauſe they manifeſt the particular concern nd agency of the infinitely wiſe Creator. The

1. Is, that man's invention ſhould reach o ſuch a great variety of matters; that it ſhould hit upon every thing that may be of any uſe, either to himſelf, or to human ſociety, or that may any ways promote (what in him lies) the benefit of this lower part of the creation.

For

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yet we ſee with what pleaſure and aſſiduity many apply themſelves to it. Thus *Cicero* tells of *Cato*, whom he caſually found in *Lucullus*'s library; 'M. Catonem vidi in bibliothecâ ſedentem, multis circumfuſum ſtoicorum libris. Erat enim, ut ſcis, in eo inexhauſta aviditas legendi, nec ſatiari poterat: quippe ne reprehenſionem quidem vulgi inanem reformidans, in ipsâ curiâ ſoleret legere ſæpe, dum ſenatus cogeretur----ut heluo librorum---videbatur.' Cic. *de finib. l.* 3. *c.* 2.

(*g*) 'Mentem hominis, quamvis eam non videas, ut Deum non vides, tamen ut Deum agnoſcis ex operibus ejus, ſic ex memoriâ rerum, & inventione, & celeritate motus, omnique pulchritudine virtutis vim divinam mentis agnoſcito.' Cic. *Tuſc. Quæſt. l.* 1. *c.* 29.

For the illuſtration of this, I might take a view of all the arts and ſciences, the trades, yea, the very tools they perform their labours, and contrivances with, as numerous as their occaſions and contrivances are various. Indeed, what is there that falleth under the reach of man's ſenſes, that he doth not employ to ſome uſe and purpoſe, for the world's good? The celeſtial bodies, the ſun, the moon, with the other planets, and the fix'd ſtars, he employs to the noble uſes of aſtronomy, navigation and geography. And what a noble acumen, what a vaſt reach muſt the ſoul be endow'd with, to invent thoſe curious ſciences of geometry and arithmetick, both ſpecious, and in numbers; and thoſe nice and various inſtruments made uſe of by the geometrician, aſtronomer, geographer and ſailor? And laſtly, what a wonderful ſagacity is ſhewn in the buſineſs of opticks, and particularly in the late invention of the teleſcope; wherewith new wonders are diſcover'd among God's works in the heavens, as there are here on earth, with the microſcope, and other glaſſes.

And as for this lower world, what material is there to be found; what kind of earth, or ſtone, or metal; what animal, tree, or plant, yea, even the very ſhrubs of the field; in a word, what of all the excellent variety, the Creator has furniſh'd the world with, for all its uſes and occaſions, in all ages; what, I ſay, that man's contrivance doth not extend unto,

nto, and make ſome way or other advantaious to himſelf, and uſeful for building, loathing, food, phyſick, or for tools or utenls, or for even only pleaſure and diverſion ?

But now conſidering the great power and xtent of human invention,

2. There is another thing that doth farther emonſtrate the ſuperintendence of the great reator and conſervator of the world; and hat is, that things of great, and abſolutely eceſſary uſe, have ſoon, and eaſily occurr'd o the invention of man; but things of little ſe, or very dangerous uſe, are rarely and lowly diſcover'd, or ſtill utterly undiſcover'd. Ve have as early as the moſaick hiſtory, an ccount of the inventions of the more uſeful rafts and occupations: Thus *Gen.* iii. 23. ' Adam was ſent forth from the garden of ' Eden, by God himſelf, to till the ground.' And in the next chapter, his two ſons Cain and Abel; the one was of the ſame occupaion, a tiller of the ground, the other a keeper of ſheep (*b*). And the poſterity of theſe, are n the latter end of *Gen.* iv. recorded; Jabal, ' to have been the father of ſuch as dwell in ' tents (*i*),' i. e. he was the inventor of tents, nd pitching thoſe moveable houſes in the ields, for looking after, and depaſturing their cattle in the deſarts, and uncultivated world. ' Tubal-Cain, was an inſtructor of every artificer

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(*b*) *Gen.* iv. 2.

(*i*) *Ver.* 20.

'tificer in braſs and iron (*k*),' or the firſt that found out the art of melting, and malleating (*l*), metals, and making them uſeful for tools, and other neceſſary implements. And his ſiſter Naamah, whoſe name is only mention'd, is by ſome thought to have been the inventor of ſpinning and cloathing. Yea, the very art of muſick is thus early aſcribed to Jubal (*m*); ſo indulgent was the Creator, to find a means to divert melancholy, to chear the ſpirits, and to entertain and pleaſe mankind. But for things of no uſe, or but little uſe, or of pernicious conſequence, either they have been much later thought of, and with great difficulty, and perhaps danger too, brought to paſs; or elſe they ſtill are, and perhaps will always remain, exerciſes of the wit and invention of men.

Of this we might give divers inſtances: in mathematicks, about ſquaring the circle (*n*); in

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(*k*) *Ver.* 22.

(*l*) Σφυροκόπος, the LXX call him; *i. e.* a worker with an hammer.

(*m*) *Ver.* 21.

(*n*) Although the quadrature of the circle, hath in former ages exercis'd ſome of the greateſt mathematical wits; yet nothing has been done in that way ſo conſiderable, as in and ſince the middle of the laſt century; when in the year 1657, thoſe very ingenious and great men, Mr. *William Neile*, and my Lord *Brounker*, and Sir *Chriſtopher Wren* afterwards, in the ſame year, geometrically demonſtrated

rated the equality of ſome curves to a ſtrait line.
oon after which, others at home and abroad, did
e like in other curves. And not long afterwards,
is was brought under an analytical calculus: The
ſt ſpecimen whereof, that was ever publiſh'd,
r. *Mercator* gave in 1688, in a demonſtration of
y Lord *Brounker*'s quadrature of the Hyperbola,
Dr. *Wallis*'s reduction of a fraction into an in-
ite ſeries, by diviſion. But the penetrating ge-
ius of Sir *Iſaac Newton*, had diſcover'd a way of
taining the quantity of all quadrible curves ana-
tically, by his method of fluxions, ſome time be-
re the year 1688, as I find very probable from
hiſtorical account, in a long letter of Mr. *Col-*
s's, written in his own hand, and ſent to *Richard*
ownley, Eſq; of *Lancaſhire*, whoſe papers are in
y hands. In that letter, Mr. *Collins* ſaith, 'That
in *September* 1668, Mr. *Mercator* publiſh'd his
Logarithmotechnia, one of which he ſoon ſent to
Dr. *Barrow*, who thereupon ſent him up ſome pa-
pers of Mr. *Newton*'s [late Sir *Iſaac*] by which,
and former communications made thereof by the
author, to the doctor, it appears, that the ſaid
method was invented ſome years before by the
ſaid Mr. *Newton*, and generally apply'd.' And
en he goes on to give ſome account of the me-
od: what it performs in the circle, &c. what
r. *Gregory* had done in that kind, 'who intended
to publiſh ſomewhat in Latin about it, but would
not anticipate Mr. *Newton*, the firſt inventor
thereof;' with much more of this nature. The
ſign, I find, of that indefatigable promoter of
athematicks, Mr. *Collins*, was to acquaint Mr.
ownley in his letter, with what had been done;
d to get the aſſiſtance of that ingenious gentle-
an, towards the compleating a body of algebra.

in mechanicks (*o*), about the art of flyin and in navigation, about finding the longitu Theſe things, although ſome of them in pearance innocent, yea, perhaps very uſef yet remain for the moſt part ſecret ; not b cauſe the diſcovery of moſt of them is mo impoſſible, or difficult than of many oth things, which have met with a diſcovery nor is it for want of man's diligence therei or his careful purſuit and enquiry after the (for perhaps, nothing already diſcover'd ha been more eagerly ſought after) but wi much better reaſon (I am ſure with grea humility and modeſty) we may conclude it i becauſe the infinitely wiſe Creator, and rul of the world, hath been pleas'd to lock theſe things from man's underſtanding and i vention, for ſome reaſons beſt known to him ſelf, or becauſe they might be of ill conſ quence, and dangerous amongſt men.

As in all probability the art of flying wou particularly be : An art which in ſome ca might be of good uſe, as to the geograph and philoſopher ; but in other reſpects, mig prove of dangerous and fatal conſequence: for inſtance, by putting it in man's power diſcover the ſecrets of nations and famili

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(*o*) I do not mention here the perpetual motio which hath exercis'd the mechanical wits for ma ages ; becauſe it is a thing impoſſible, if not a co tradiction : as the before-commended Dr. *Clarke* ſerts in Rohaul. *Phyſ. p.* 133.

more than is conſiſtent with the peace of the world for men to know; by giving ill men greater opportunities to do miſchief, which it would not lie in the power of others to prevent; and, as one (*p*) obſerves, by making men leſs ſociable: ‘ For upon every true or ‘ falſe ground of fear, or diſcontent, and other ‘ occaſions, he would have been fluttering ‘ away to ſome other place; and mankind, ‘ inſtead of cohabiting in cities, would, like ‘ the eagle, have built their neſts upon rocks.’

That this is the true reaſon of theſe matters, is manifeſt enough from holy ſcripture; and reaſon (*q*) alſo gives its ſuffrage thereto. The ſcripture expreſly tells us, that ‘ every good ‘ gift, and every perfect gift, is from above, ‘ and cometh down from the father of lights,’ St *James* i. 17. Solomon, *Prov.* ii. 6. ſaith, ‘ The Lord giveth wiſdom; out of his mouth ‘ cometh knowledge and underſtanding.’ And Elihu is very expreſs, *Job* xxxii. 8. ‘ But there is a ſpirit in man: and the inſpi‘ration of the Almighty giveth them under‘ſtanding,, Πνοὴ παντοκράτορός ἐστιν ἡ διδάσκουσα, as the LXX render it, ‘ The inſpiration, the ‘ afflatus of the Almighty, is their inſtructor, ‘ miſtreſs, or teacher. And in ſcripture, not only the more noble, ſuperior acts of wiſdom or ſcience, but much inferior alſo, bear the name

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(*p*) Grew's *Coſmol. ſacr. l.* 1. *c.* 5. § 25.

(*q*) ‘ Nemo igitur vir magnus ſine aliquo afflatu ‘ divino unquam fuit.’ Cic. *de nat. deor. l.* 2. *c.* 66.

name of wiſdom, knowledge and underſtanding, and are aſcribed unto God. 'Tis well known that Solomon's wiſdom is wholly aſcribed unto God; and the wiſdom and underſtanding which God is ſaid to have given him, 1 *Kings* iv. 29. is particularly ſet forth in the following verſes, by his great ſkill in moral and natural philoſophy, in poetry, and probably in aſtronomy, geometry, and ſuch other of the politer ſciences, for which Egypt, and the Eaſtern nations were celebrated of old (*r*): 'And Solomon's wiſdom excelled the wiſdom of all the children of the eaſt-country, and all the wiſdom of Egypt. For he was wiſer than all men, than Ethan, &c. And he ſpake 3000 proverbs: and his ſongs were 1005. And he ſpake of trees, from the cedar to the hyſſop of the wall (i. e. of all ſorts of plants) alſo of beaſts, fowl, creeping things, and fiſhes.' So likewiſe the wiſdom of Daniel, and his three companions, is aſcribed unto God, *Dan.* i. 17. 'And for theſe four children, God gave them knowledge, and ſkill in all learning and wiſdom; and Daniel had underſtanding in all viſions 'and

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(*r*) *Egypt*, and ſome of the Eaſtern nations, are celebrated for their ſkill in polite literature; both in ſcripture and profane ſtory: *Job* was of thoſe parts; ſo were the Σοφοὶ and Μάγοι, the Brachmans and Gymnoſophiſts. *Moſes* and *Daniel* had their education in theſe parts: And *Pythagoras*, *Democritus*, and others, travell'd into theſe parts for the ſake of their learning.

'and dreams.' And accordingly in the next chapter, Daniel acknowledgeth and praiſeth God, ver. 20, 21. 'Daniel an-'ſwered and ſaid, bleſſed be the name of God 'for ever and ever, for wiſdom and might 'are his------- He giveth wiſdom unto the 'wiſe, and knowledge to them that know 'underſtanding.' But not only ſkill in the ſuperior arts and ſciences, but even in the more inferior mechanick arts, is called by the ſame names, and aſcribed unto God. Thus for the workmanſhip of the tabernacle, *Exod.* xxxi. 2. to ver. 6. 'See, I have called Beza-'leel; and I have filled him with the ſpirit 'of God, in wiſdom, and in underſtanding, 'and in all manner of workmanſhip: to de-'viſe cunning works, to work in gold, ſilver 'and braſs; and in cutting of ſtones, to ſet 'them; and in carving of timber, to work in 'all manner of workmanſhip.' So the ſpinſters, weavers, and other crafts-people, are called wiſe-hearted, *Exod.* xxxiv. 10, 25. and other places. And in *Exod.* xxxvi. 1, &c. the Lord is ſaid to have put this wiſdom in them, and underſtanding to know how to work all theſe manner of works, for the ſervice of his ſanctuary. And laſtly, to name no more inſtances, Hieram the chief architect of Solomon's temple, is in 1 *Kings* vii. 14. and 2 *Chron.* ii. 14. called 'a cunning man, 'filled with wiſdom and underſtanding, to 'work in gold, ſilver, braſs, iron, ſtone, ‘timber, purple, blue, fine linnen, and crimſon; alſo to grave, and find out every device which ſhould be put to him.’

Thus doth the word of God aſcribe the contrivances and crafts of men, to the agency, or influence of the ſpirit of God, upon that of man. And there is the ſame reaſon for the variety of genii, or inclinations of men alſo; which from the ſame ſcriptures may be concluded to be a deſignation and tranſaction of the ſame almighty governor of the world's affairs. And who indeed but he, could make ſuch a divine ſubſtance, endowed with thoſe admirable faculties and powers, as the rational ſoul hath; a being to bear the great Creator's vice-gerency in this lower world; to employ the ſeveral creatures; to make uſe of the various materials; to manage the grand buſineſs; and to ſurvey the glories of all the viſible works of God? a creature, without which this lower world would have been a dull, uncouth, and deſolate kind of globe. Who, I ſay, or what leſs than the infinite God, could make ſuch a rational creature, ſuch a divine ſubſtance as the ſoul! For, if we ſhould allow the Atheiſt any of his nonſenſical ſchemes, the Epicurean his fortuitous concourſe of atoms, or the Carteſian (s) his created matter put in

motion;

(s) As we are not to accuſe any falſly, ſo far be it from me to detract from ſo great a man as Monſieur *Cartes* was; whoſe principles, although many have perverted to atheiſtical purpoſes, and whoſe

notions

motion; yet with what tolerable ſenſe could he, in his way, produce ſuch a divine thinking, ſpeaking, contriving ſubſtance as the ſoul is; endowed exactly with ſuch faculties, powers and diſpoſitions, as the various neceſſities and occaſions of the world require from ſuch a creature? Why ſhould not rather all the acts, the diſpoſitions and contrivances of ſuch a creature as man, if made in a mechanical way, and not contrived by God, have been the ſame? Particularly, why ſhould he not have hit upon all contrivances of equal uſe, early, as well as many ages ſince? why not that man have effected, as well as this, ſome thouſand of years after? why alſo ſhould not all nations, and all ages (*t*), im-

prove

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notions have, ſome of them, but an ill aſpect, yet I am unwilling to believe he was an atheiſt; ſince in his *Principia Philoſophiæ*, and other of his works, he vindicates himſelf from this charge; and frequently ſhews ſeemingly a great reſpect for religion: Beſides that, many of his ſuſpicious opinions are capable of a favourable interpretation, which will make them appear in a better form: Thus when he diſcardeth final cauſes from his philoſophy, it is not a denial of them; but only excluding the conſideration of them, for the ſake of free philoſophizing; it being the buſineſs of a divine, rather than a philoſopher, to treat of them.

(*t*) For ages of learning and ignorance, we may compare the preſent, and ſome of the ages before the reformation. The laſt century, and the few years of this, have had the happineſs to be able to prove in every thing, as well as this, or that age, vie with any age for the number of learned men of all profeſſions, and the improvement made in all arts and ſciences; too many, and too well known to need a ſpecification.

But for ignorance, we may take the ninth age, and ſo down to the reformation; even as low as Queen *Elizabeth*, although learning began to flouriſh; yet we may gueſs how matters ſtood, even among the clergy, by her 53d *Injunct.* N° 1559. ‘Such as are but mean readers, ſhould peruſe over before, once or twice, the chapters and homilies, to the intent they may read to the better underſtanding of the people, the more encouragement of godlineſs.’ Spar. *Collect. p.* 82. But this is nothing, in compariſon to the ages before, when the monk ſaid, *Græcum non eſt legi*; or as *Eſpencæus* more elegantly hath it, *Græce nôſſe ſuſpectum, hebraicè prope hæreticum.* Which ſuſpicion (ſaid the learned *Hakewill*) *Rhemigius* ſurely was not guilty of, in commenting upon *diffamatus*, 1 *Theſſ.* i. 8. who ſaith, St. *Paul* ſomewhat improperly put that for *divulgatus*, not being aware that St. *Paul* wrote in Greek, and not in Latin. Nay, ſo great was their ignorance, not only of Greek, but of Latin too, that a prieſt baptized *in nomine patria, & filia, ſpiritua ſancta.* Another ſuing his pariſhioners for not paving his church, proved it from *Jer.* xvii. 18. *paveant illi, non paveam ego.* Some divines in *Eraſmus*'s time, undertook to prove hereticks ought to be burnt, becauſe the apoſtle ſaid, *Hæreticum devita.* Two friers diſputing about a plurality of worlds, one proved it from *Annon decem ſunt facti mundi?* The other replied, *Sed ubi ſunt novem?* And, notwithſtanding their ſervice was read in Latin, yet ge, or nation (*u*) only? why ſhould the Greeks, the Arabians, the Perſians, or the Egyptians of old, ſo far exceed thoſe of the ſame

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ſo little was that underſtood, that an old prieſt in *Henry* VIII. read *mumpſimus Domine* for *ſumpſimus*: and being admoniſhed of it, he ſaid, he had done ſo for thirty years, and would not leave his old *mumpſimus* for their new *ſumpſimus*. *Vide* Hakew. *Apol. l.* 3. *c.* 7. § 2.

(*u*) 'There is (it ſeems) in wits and arts, as in all things beſide, a kind of circular progreſs: They have their birth, their growth, their flouriſhing, their failing, their fading; and within a while after, their reſurrection, and reflouriſhing again. The arts flouriſhed for a long time among the Perſians, the Chaldæans, the Egyptians.----- But afterwards the Grecians got the ſtart of them,' and are now become as barbarous themſelves, as formerly they eſteemed all beſides themſelves to be. About the birth of Chriſt, learning began to flouriſh in *Italy*, and ſpread all over Chriſtendom, till the Goths, Huns, and Vandals, ranſacked the libraries and defaced almoſt all the monuments of antiquity: ſo that the lamp of learning ſeemed to be put out, for near the ſpace of 1000 years, till the firſt *Manſor*, king of *Africa* and *Spain*, raiſed up, and ſpurred forward the Arabian wits, by great rewards and encouragements. Afterwards *Petrarch* opened ſuch libraries as were undemoliſhed. He was ſeconded by *Boccace*, and *John* of *Ravenna*, and ſoon after by *Aretine*, *Philelphus*, *Valla*, &c. And thoſe were followed by *Æneas Sylvius*, *Angelus Politianus*, *Hermolaus Barbarus*, *Marſilius Ficinus*, and *Joh. Picus* of *Mirandula*. Theſe were backed by *Rud. Agricola*, *Reucline*, ſame nations now? why the Africans and Americans ſo generally ignorant and barbarous, and the Europeans, for the moſt part, polite and cultivated, addicted to arts and learning? how could it come to paſs, that the uſe of the magnet (*w*), printing (*x*),

clocks,

Reucline, *Melancthon*, *Joach. Camerarius*, *Wolph. Lazius*, *Beat. Rhenanus*, Almaines: by *Eraſmus* of *Roterdam*; *Vives*, a Spaniard; *Bembus*, *Sadoletus*, *Eugubinus*, Italians: *Turnebus*, *Muretus*, *Ramus*, *Pithæus*, *Budæus*, *Amiot*, *Scaliger*, Frenchmen: Sir *Tho. More*, and *Linaker*, Engliſhmen. And about this time, even thoſe northern nations yielded their great men: *Denmark* yielded *Olaus Magnus*, *Holſter*, *Tycho Brahe*, and *Hemingius*; and *Poland*, *Hoſtus*, *Frixius*, and *Crumerus*. But to name the worthies that followed theſe, down to the preſent time, would be endleſs, and next to impoſſible. See therefore Hakewill's *Apolog*. *l*. 3. *c*. 6. § 2.

(*w*) Dr. *Gilbert*, the moſt learned and accurate writer on the Magnet, ſhews, that its attractive virtue was known as early as *Plato* and *Ariſtotle*; but its direction was a diſcovery of later ages. He ſaith, 'Superiori ævo 300 aut 400 labentibus annis, motus magneticus in boream & auſtrum repertus, aut ab hominibus rurſus recognitus fuit.' *De mag*. *l*. 1. *c*. 1. But who the happy inventer of this lucky diſcovery was, is not known. There is ſome, not inconſiderable, reaſon, to think our famous countryman, *Roger Bacon*, either diſcovered, or at leaſt knew of it. But for its uſe in navigation, Dr. *Gilbert* ſaith, 'In regno Neapolitano 'Melphitani omnium primi (uti ferunt) pyxidem 'inſtruebant nauticam------edocti à cive quodam

'Jol.

Jol. Goia, A. D. 1300. *ibid.* If the reader hath a mind to ſee the arguments for the invention being as old as *Solomon*'s or *Plautus*'s time, or of much younger date, he may conſult *Hakewill,* ibid. *c.* 10. § 4. or Purchas *Pilgr. l.* 1. *c.* 1. § 1.

As to the magnetick variation, Dr. *Gilbert* attributes the diſcovery of it to *Sebaſtian Cabott.* And the inclination or dipping of the needle, was the diſcovery of our ingenious *Rob. Norman.* And laſtly, the variation of the variation, was firſt found out by the ingenious Mr. *H. Gellibrand,* Aſtr. Prof. of *Greſh. Coll.* about 1634. *Vide* Gellibr. *Diſc. math. on the variation of the mag. needle, and its variat.* Anno 1635.

But ſince that, the before-commended Dr. *Halley,* having formerly, in *Phil. Tranſ.* N° 148, and 195, given a probable hypotheſis of the variation of the compaſs, did, in the year 1700, undertake a long and hazardous voyage, as far as the ice near the ſouth pole, in order to examine his ſaid hypotheſis, and to make a ſyſtem of the magnetical variations: which being ſoon after publiſhed, has been ſince abundantly confirmed by the French, as may be ſeen in ſeveral of the late *Memoires de phyſique & de mathematique,* publiſhed by the French *academie des ſciences.*

To theſe diſcoveries, I hope the reader will excuſe me, if I add one of my own, which I deduced ſome years ago, from ſome magnetical experiments and obſervations I made; which diſcovery I alſo acquainted our Royal Society with, ſome time ſince; viz. That as the common, horizontal needle, is continually varying up and down, towards the E. and W. ſo is the dipping-needle varying up and down towards or fromwards the zenith, with its magnetick tendency, deſcribing a circle round the pole of the

the world, as I conceive, or ſome other point. So that if we could procure a needle ſo nicely made, as to point exactly according to its magnetick direction, it would, in ſome certain number of years, deſcribe a circle of about 13 gr. radius, round the magnetick poles, northerly and ſoutherly. This I have for ſeveral years ſuſpected, and have had ſome reaſon for it too, which I mentioned three or four years ago, at a meeting of our Royal Society; but I have not yet been ſo happy to procure a tolerable good dipping-needle, or other proper one to my mind, to bring the thing to a ſufficient teſt of experience, as in a ſhort time I hope to do, having lately hit upon a contrivance that may do the thing.

(x) It is uncertain who was the inventer of the art of Printing, every hiſtorian aſcribing the honour thereof to his own city or country. Accordingly, ſome aſcribe the invention of it to *John Guttenburg*, a Knight of *Argentine*, about 1440, and ſay, that *Fauſtus* was only his aſſiſtant. *Bertius* aſcribes it to *Laurence John*, of *Haerlem*, and ſaith, *Fuſt*, or *Fauſt*, ſtole from him both his art and tools. And, to name no more, ſome attribute it to *John Fuſt*, or *Fauſt*, and *Peter Schoeffer* (called by *Fuſt*, in ſome of his Imprimaturs, *Pet de Gerneſhem puer meus*). But there is now to be ſeen at *Haerlem*, a book or two printed by *Lau. Koſter*, before any of theſe; viz. in 1430, and in 1432. (See *Mr.* Ellis's *letter to Dr.* Tyſon, in *Philoſ. Tranſ.* N° 286.) But be the firſt inventer who it will, there is however great reaſon to believe, the art received great improvements from *Fauſt*, and his ſon-in-law *Schoeffer*, the latter being the inventer of metalline types, which were cut in wood before, firſt in whole blocks, and afterwards in ſingle types or letters. See my learned friend Mr. *Wanley*'s obſervations, in *Philoſ. Tranſact.* N° 288, and 310.

clocks (y), teleſcopes (z),and an hundred things beſides, ſhould eſcape the diſcovery of Archimedes, Anaximander, Anaximenes, Poſidonius, or other great virtuoſo's of the early ages, whoſe contrivances of various engines, ſpheres, clepſydræ, and other curious inſtruments are recorded (aa)? And why cannot the preſent or paſt

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(y) Concerning the antiquity and invention of clocks and clock-work, I refer the reader to a little book, called, *The artificial Clock-maker, chap.* 6. where there is ſome account of the ancients inventions in clock-work, as *Archimedes*'s ſphere, *Cteſibius*'s clock, &c.

(z) The invention of teleſcopes, *Hieron. Syrturus* gives this account of. 'Prodiit anno 1609, ſeu genius, ſeu alter vir adhuc incognitus, Hollandi ſpecie, qui Middelburgi in Zelandiâ convenit Joh. Lipperſein-----Juſſit per ſpicilla plura tam cava quam convexa, confici. Condicto die rediit, abſolutum opus capiens, atque ut ſtatim habuit præ manibus, bina ſuſcipiens, cavum ſcil. & convexum, unum & alterum oculo admovebat. & ſenſim dimovebat, ſive ut punctum concursûs, ſive ut artificis opus probaret, poſtea abiit. Artifex, ingenii minimè expers, & novitatis curioſus cœpit idem facere & imitari, &c.' *Vide* Mus. Worm. 4. c. 7.

(aa) Among the curious inventions of the ancients, *Archytas*'s Dove was much famed; of which *Aul. Gellius* gives this account: 'Scripſerunt ſimulachrum columbæ è ligno ab Archytâ ratione quâdam diſciplinâque mechanicâ factum, volaſſe: Ita erat ſcilicet libramentis ſuſpenſum, & aurâ ſpiritûs incluſâ atque occultâ concitum.' *Noct. Attic.* l. 10.

paſt age, ſo eminent for polite literature, for diſcoveries and improvements in all curious arts

l. 10. *c.* 12. The ſame eminent Pythagorean philoſopher (as *Favorinus* in *Gellius* calls him) is by *Horace* accounted a noble geometrician too; 'Te maris '& terræ, numeroque carentis arenæ menſorem 'Archyta.' Among the reſt of his inventions, children's rattles are aſcribed to him. *Ariſtotle* calls them Ἀρχύτȣ πλαταγὴ, *Polit.* 8. i. e. *Archytas's* rattle. And *Diogenianus*, the grammarian, gives the reaſon of his invention, Ἀρχύτȣ πλαταγὴ ἐπὶ τόν, &c. 'That *Archytas*'s rattle was to quiet children; for 'he having children, contrived the rattle, which 'he gave them to prevent their tumbling [διασαλεύωσι] other things about the houſe.'

To theſe contrivances of *Archytas*, we may add '*Rigiomontanus*'s wooden Eagle, which flew forth 'of the city, aloft in the air, met the emperor a 'good way off, coming towards it, and having ſaluted him, return'd again, waiting on him to the 'city gates. Alſo his iron fly, which at a feaſt 'flew forth off his hands, and taking a round, 'returned thither again.' *Vide* Hakewill, *ubi ſupra*, *c.* 10. § 1.

As to other inventions of the ancients, ſuch as of letters, bricks, and tiles, building houſes, with the ſaw, rule, and plummet, the lath, augre, glue, &c. alſo the making braſs, gold, and other metals; the uſe of ſhields, ſwords, bows and arrows, boots, and other inſtruments of war; the pipe, harp, and other muſical inſtruments; the building of ſhips, and navigation, and many other things beſides; the inventers of theſe (as reported by ancient heathen authors) may be plentifully met with in *Pliny*, *Nat. hiſt.* *l.* 7. *c.* 56.

B

arts and buſineſſes (perhaps beyond any known age of the world; why cannot it, I ſay) diſcover thoſe hidden Quæſita, which may probably be reſerved for the diſcovery of future and leſs learned generations?

Of

But in this account of *Pliny*, we may obſerve whence the ancients (even the Romans themſelves in ſome meaſure) had their accounts of theſe matters; viz. from the fabulous Greeks, who were fond of aſcribing every thing to themſelves. The 'truth is (ſaith the moſt learned biſhop *Stillingfleet*) 'there is nothing in the world uſeful or beneficial 'to mankind, but they have made a ſhift to find 'the author of it among themſelves. If we enquire 'after the original of agriculture, we are told of '*Ceres* and *Triptolemus*; if of paſture, we are told of 'an Arcadian *Pan*; if of wine, we preſently hear of 'a *Liber Pater*; if of iron inſtruments, then who 'but *Vulcan!* if of muſick, none like to *Apollo*. If 'we preſs them with the hiſtory of other nations, 'they are as well provided here; if we enquire an 'account of *Europe*, *Aſia*, or *Lybia*; for the firſt, 'we are told a fine ſtory of *Cadmus*'s ſiſter; for the 'ſecond, of *Prometheus*'s mother of that name; and 'for the third, of a daughter of *Epaphus*.' And ſo the learned author goes on with other particular nations, which they boaſted themſelves to be the founders of. 'Only the grave Athenians thought 'ſcorn to have any father aſſigned them; their 'only ambition was to be accounted *Aborigines &* '*genuini terræ*.' But the ignorance and vanity of the Greek hiſtory, that learned author hath ſufficiently refuted. *Vide* Stilling. *Orig. ſacr. part* I. *book* i. *chap.* 4.

Of theſe matters, no ſatisfactory account can be given by any mechanical hypotheſis, or any other way, without taking in the ſuperintendence of the great Creator and ruler of the world; who oftentimes doth manifeſt himſelf in ſome of the moſt conſiderable of thoſe works of men, by ſome remarkable tranſactions of his providence, or by ſome great revolution or other happening in the world thereupon. Of this I might inſtance in the invention of printing (*bb*), ſucceeded firſt by a train of learned men, and the revival of learning, and ſoon after that by the reformation, and the much greater improvements of learning at this day. But the moſt conſiderable inſtance I can give is, the progreſs of chriſtianity, by means of the civilized diſpoſition, and large extent of the Roman empire. The latter of which, as it made way for human power, ſo the former made way for our moſt excellent religion into the minds of men. And ſo I hope, and earneſtly pray, that the omnipotent and all-wiſe ruler of the world will tranſact the affairs of our moſt holy religion, e're it be long, in the heathen

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(*bb*) Whether Printing was invented in 1440, as many imagine, or was ſooner practiſed, in 1430, or 1432, as Mr. *Ellis*'s account of the Dutch inſcription, in *Philoſ. Tranſact.* N° 286. doth import; it is however manifeſt, how great an influence (as it was natural) this invention had in the promoting of learning ſoon afterwards, mentioned before in note (*x*). After which followed the reformation, about the year 1517.

heathen world, that the great improvements made in the laſt, and preſent age, in arts and ſciences, in navigation and commerce, may be a means to tranſport our religion, as well as name, through all the nations of the earth. For we find that our culture of the more polite and curious ſciences, and our great improvements in even the mechanick arts, have already made a way for us into ſome of the largeſt and fartheſt diſtant nations of the earth; particularly into the great empire of China (*cc*).

And

(*cc*) The Chineſe being much addicted to judicial aſtrology, are great obſervers of the heavens, and the appearances in them. For which purpoſe they have an Obſervatory at *Pekin*, and five mathematicians appointed to watch every night; four towards the four quarters of the world, and one towards the zenith, that nothing may eſcape their obſervation: which obſervations are the next morning brought to an office to be regiſtered. But notwithſtanding this their diligence for many ages, and that the emperor hath kept in his ſervice above 100 perſons, to regulate the kalendar, yet are they ſuch mean aſtronomers, that they owe the regulation of their kalendar, the exactneſs in calculating eclipſes, &c. to the Europeans; which renders the European mathematicians ſo acceptable to the emperor, that father *Verbeiſt*, and divers others, were not only made principals in the obſervatory, but put into places of great truſt in the empire, and had the greateſt honours paid them at their deaths. *Vide* La Comte *mem. of* China, *letter* 2. &c.

And now, before I quit this ſubject, I cannot but make one remark, by way of practical inference, from what has been laſt ſaid; and that is, ſince it appears that the ſouls of men are ordered, diſpoſed and actuated by God, even in ſecular, as well as ſpiritual chriſtian acts, a duty ariſeth thence on every man, to purſue the ends, and anſwer all the deſigns of the divine providence, in beſtowing his gifts and graces upon him. Men are ready to imagine their wit, learning, genius, riches, authority, and ſuch like, to be works of nature, things of courſe, or owing to their own diligence, ſubtilty, or ſome ſecondary cauſes; that they are maſters of them, and at liberty to uſe them as they pleaſe, to gratify their luſt or humour, and ſatisfy their depraved appetites. But it is evident, that theſe things are the gifts of God, they are ſo many talents entruſted with us by the infinite Lord of the world, a ſtewardſhip, a truſt repoſed in us; for which we muſt give an account at the day when our Lord ſhall call; according to the parabolical repreſentation of this matter by our bleſſed ſaviour, *Matth.* xxv. 14.

Our duty then is, not to abuſe theſe gifts of God, 'not to neglect the gift that is in us,' not to 'hide our talent in the earth;' but as St. Paul exhorteth Timothy, 2. *Tim.* i. 6. we muſt 'ſtir up the gift of God which is in us,' and not let it lie idle, concealed, or dead; but we we muſt ἀναζωπυρεῖν τὸ χάρισμα, 'blow it up, and enkindle it,' as the original imports; we muſt improve and employ our gift to the glory of the giver; or in that miniſtration, that uſe and ſervice of the world, for which he gave it. Our ſtewardſhip, our craft, our calling, be it that of ambaſſadors of heaven, committed to us, as it was to Timothy *(dd)*, by the laying on of hands; or be it the more ſecular buſineſs of the gentleman, tradeſman, mechanick; or only ſervant; nay, our good genius, our propenſity to any good, as ſuppoſe to hiſtory, mathematicks, botany, natural philoſophy, mechanicks, &c. I ſay, all theſe occupations, in which the providence of God, hath engaged men, all the inclinations to which his ſpirit hath diſpoſed them, ought to be diſcharged with that diligence, that care and fidelity, that our great lord and maſter may not ſay to us, as was ſaid to the unfaithful ſteward, *Luke* xvi. 2. 'Give an account of thy ſtewardſhip, for thou mayeſt be no longer ſteward;' but that he may ſay as it is in the parable before-cited, *Matth.* xxv. 21. 'Well done, thou good and faithful ſervant, thou haſt been faithful over a few things, I will make thee ruler over many things, enter thou into the joy of thy Lord.' Since now the caſe is thus, let us be perſuaded to follow Solomon's advice, *Eccleſ.* ix. 10. 'Whatſoever thy hand findeth

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(dd) 1 *Tim.* iv. 14. 2 *Tim.* i. 6.

'findeth thee to do, do it with thy might (*ee*):'
"Lay hold on every occaſion that preſents it-
"ſelf, and improve it with the utmoſt dili-
"gence; becauſe now is the time of action,
"both in the employments of the body, and
"of the mind; now is the ſeaſon of ſtudying
"either arts and ſciences, or wiſdom and vir-
"tue, for which thou wilt have no opportu-
"nities in the place whither thou art going in
"the other world. For there is no work,
"nor device, nor knowledge, nor wiſdom in
"the grave, whither thou goeſt."

(*ee*) Biſhop *Patrick* in loc.

CHAP. II.

Of Man's *Body, particularly its Poſture.*

HAVING thus, as briefly as I well could, ſurveyed the ſoul, let us next take a view of man's body Now here we have ſuch a multiplicity of the moſt exquiſite workmanſhip, and of the beſt contrivance, that if we ſhould ſtrictly ſurvey the body from head to foot, and ſearch only into the known parts (and many more lie undiſcovered) we ſhould find too large and tedious a taſk to be diſpatched. I ſhall therefore have time only to take a tranſient and general kind of view of this admirable machine, and that ſomewhat briefly too, being prevented by others, partiularly two excellent authors of our own (a), who have done it on the ſame account as myſelf. And the

Iſt thing that preſents itſelf to our view, is the erect poſture (b) of man's body; which is far the moſt, if not the only commodious poſture for a rational creature, for him that hath dominion over the other creatures, for one that can invent uſeful things, and practiſe curious arts. For without this erect poſture, he could not have readily turned himſelf to every buſineſs, and on every occaſion. His hand (c) particu-

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(a) Mr. *Ray*, in his *Wiſdom of God manifeſted in the works of creation, part* 2. And Dr. *Cockburn*'s *Eſſay on faith, part* 1. *eſſay* 5.

(b) ' Ad hanc providentiam naturæ tam diligen-' tem [of which he had been before ſpeaking] tam-' que ſolertem adjungi multa poſſunt, è quibus in-' telligatur, quantæ res hominibus à Deo, quamque ' eximiæ tributæ ſunt: qui primum eos humo ex-' citatos, celſos & erectos conſtituit, ut deorum ' cognitionem, cœlum intuentes, capere poſſent. ' Sunt enim è terrâ homines, non ut incolæ, atque ' habitatores, ſed quaſi ſpectatores ſuperarum rerum, ' atque cœleſtium, quarum ſpectaculum ad nullum ' aliud genius animantium pertinet.' Cic. *de nat. deor. l.* 2. *c.* 56.

(c) ' Ut autem ſapientiſſimum animalium eſt ' homo, ſic & manus ſunt organa ſapienti animali ' convenientia. Non enim quia manus habuit, ' propterea eſt ſapientiſſimum, ut Anaxagoras di-' cebat; ſed quia ſapientiſſimum erat, propter hoc ' manus habuit, ut rectiſſimè cenſuit Ariſtoteles. ' Non enim manus ipſæ hominem artes docuerunt, ' ſed

‘ ſed ratio. Manus autem ipſæ ſunt artium organum, &c. Galen. *de uſ. part. l.* 1. *c.* 3. After which, in the reſt of this firſt book, and part of the ſecond, he conſiders the particulars of the hand, in order to enquire, as he ſaith, *ch.* 5. ‘Num eam ‘ omnino conſtitutionem habeat [manus] quâ meliorem aliam habere non potuit.’

Of this part (and indeed of the other parts o human bodies) he gives ſo good an account, that I confeſs I could not but admire the ſkill of that ingenious and famed heathen. For an example (becauſe it is a little out of the way) I ſhall pitch upon his account of the different length of the fingers; *lib.* 1. *chap.* 24. The reaſon of this mechaniſm, he ſaith, is, that the tops of the fingers may come to an equality. ‘Cùm magnas aliquas moles in ‘ circuit comprehendunt, & cùm in ſeipſis humidum ‘ vel parvum corpus continere conantur.----Apparent verò in unam circuli circumferentiam convenire digiti quinque in actionibus hujuſmodi, ‘ maximè quando exquiſitè ſphæricum corpus comprehendunt.’ And this evenneſs of the fingers ends, in graſping ſpherical and other round bodies, he truly enough ſaith, makes the hold the firmer. And it ſeems a noble and pious deſign he had in ſ ſtrictly ſurveying the parts of man's body, which take in his own tranſlated words, ‘Cùm mult ‘ namque eſſet apud veteres, tam medicos, quam ‘ philoſophos de utilitate particularum diſſenſio (quidam enim corpora noſtra nullius gratiâ eſſe fact ‘ exiſtimant, nullâque omnino arte; alii autem & ‘ alicujus gratiâ, & artificioſè----) primum quidem ‘ tantæ hujus diſſentionis κριτήριον invenire ſtudui ‘ deinde verò & unam aliquam univerſalem methodum conſtituere, quâ ſingularum partium corporis, & eorum quæ illis accidunt utilitatem invenire poſſemus.’ *Ibid. cap.* 8.

particularly could not have been in ſo great a readineſs to execute the commands of the will, and dictates of the ſoul. His eyes would have been the moſt prone, and incommodiouſly ſituated of all animals; but by this ſituation, he can caſt his eyes upwards, downwards, and round about him; he hath a glorious hemiſphere of the heavens (*d*), and an ample horizon on earth (*e*), to entertain his eye.

And

(*d*) *Pronaque cum ſpectant animalia cætera terram,*
Os homini ſublime dedit, cœlumque tueri
Juſſit, & erectos ad ſidera tollere vultus.
Ovid. Metam. l. 1. car. 84.

(*e*) If any ſhould be ſo curious, to deſire to know how far a man's proſpect reacheth, by means of the height of his eye, ſuppoſing the earth was an uninterrupted globe; the method is a common caſe of right-angled plain triangles, where two ſides, and an oppoſite angle are given: Thus in *fig.* 4. *AHB* is the ſurface, or a great circle of the terraqueous globe; *C* the center, *HC* its ſemidiameter, *E* the height of the eye; and foraſmuch as *HE* is a tangent, therefore the angle at *H* is a right angle: ſo that there are given *HC* 398,386 miles or 21,034,781 Engliſh feet (according to *book* ii. *chap.* 2. *note* (*a*)) *CEE* the ſame length with the height of the eye, on the maſt of a ſhip, or at only a man's height, &c. added to it; and *EHC* the oppoſite right angle. By which three parts given, it is eaſy to find all the other parts of the triangle. And firſt, the angle at *C*, in order to find the ſide *HE*, the proportion is, as the ſide *CE*, to the angle at *H*; ſo the ſide *HC*, to the angle at *E*; which being ſubſtracted out of 90 gr. the remainder is the angle at

And as this erection of man's body is the moſt compleat poſture for him; ſo if we ſurvey the proviſion made for it, we find all done with

at *C*. And then, as the angle at *E*, is to its oppoſite ſide *H C*, or elſe as the angle at *H* is to its oppoſite ſide *C E*; ſo the angle at *C*, to its oppoſite ſide *E H*, the viſible horizon. Or the labour may be ſhorten'd, by adding together the logarithm of the ſum of the two given ſides, and the logarithm of their difference; the half of which two logarithms is the logarithm of the ſide requir'd, nearly. For an example, we will take the two ſides in yards; by reaſon ſcarce any table of logarithms will ſerve us farther. The ſemidiameter of the earth is 7,011,594 yards; the height of the eye is two yards more, the ſum of both ſides is, 14,023,190.

Logar. of which ſum is, - - - - -	7,1468468
Logar. of two yards (the difference) is	0,3010300
Sum of both logar. - - - - - - - -	7,4478768
The half ſum, - - - - - - - - - - -	3,7239384

is the logarithm of 5296 yards = three miles, which is the length of the line *E H*, or diſtance the eye can reach at ſix feet height.

This would be the diſtance, on a perfect globe, did the viſual rays come to the eye in a ſtrait line; but by means of the refractions of the atmoſphere, diſtant objects on the horizon appear higher than really they are, and may be ſeen at a greater diſtance, eſpecially on the ſea; which is a matter of great uſe, eſpecially to diſcover at ſea the land, rocks, &c. and it is a great act of the divine providence, in the contrivance and convenience of the atmoſphere, vith manifeſt deſign, the utmoſt art and ſkill eing employ'd therein. To paſs by the par-icular conformation of many of the parts, he ligaments and faſtenings to anſwer this oſture; as the faſtenings, for inſtance, of he pericardium to the diaphragm (which is eculiar to man (*f*); I ſay, paſſing by a deal f this nature, manifeſting this poſture to be n act of deſign) let us ſtop a little at the cu-ious fabrick of the bones, thoſe pillars of the ody. And how artificially do we find them nade, how curiouſly placed from the head to he foot! the vertebræ of the neck and back-one (*g*), made ſhort and complanated, and irmly braced with muſcles and tendons, for aſy incurvations of the body; but withal for reater ſtrength, to ſupport the body's own veight, together with other additional weights t may have occaſion to bear; the thigh bones nd legs long, and ſtrong, and every way well itted for the motion of the body. The feet ccommodated with a great number of bones, uriouſly and firmly tack'd together: to which

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atmoſphere, which by this means enlargeth the viſible horizon, and is all one, as if the terraqueous globe was much larger than really it is. As to the height of the apparent above the true level; or, ow much diſtant objects are raiſed by the refrac-tions, the ingenious and accurate gentlemen of the French Academy Royal, have given us a table in their meaſures of the earth, *Art.* 12.

(*f*) See *book* vi. *chap.* 5. to *note* (*g*).

(*g*) See *book* iv. *chap.* 8. *note* (*c*).

which muſt be added the miniſtry of the muſcles (*b*), to anſwer all the motions of the legs and thighs, and at the ſame time to keep the body upright, and prevent its falling, by readily aſſiſting againſt every vacillation thereof, and with eaſy and ready touches keeping

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(*b*) The mechaniſm of the foot would appear to be wonderful, if I ſhould deſcend to a deſcription of all its parts; but that would be too long for theſe notes; therefore a brief account (moſt of which I owe to the before-commended Mr. *Cheſelden*) may ſerve for a ſample: In the firſt place, it is neceſſary the foot ſhould be concave, to enable us to ſtand firm, and that the nerves and blood-veſſels may be free from compreſſion, when we ſtand or walk. In order hereunto, the long flexors of the toes croſs one another at the bottom of the foot, in the form of a St. *Andrew*'s croſs, to incline the leſſer toes towards the great one, and the great one towards the leſſer. The ſhort flexors are chiefly concern'd in drawing the toes towards the heel. The tranſverſalis pedis draws the outſides of the foot towards each other; and by being inſerted into one of the ſeſamoid bones of the great toe, diverts the power of the Abductor muſcle, falſly ſo called, and makes it become a flexor. And laſtly, the Peronæus Longus runs round the outer ankle, and obliquely forwards croſs the bottom of the foot, and at once helps to extend the Tarſus, to conſtrict the foot, and to direct the power of the other extenſors towards the ball of the great toe: Hence the loſs of the great toe, is more than of all the other toes. See alſo Mr. Cowper's *Anat. Tab.* 28, *&c.*

keeping the line of innexion, and centre of gravity, in due place and poſture (*i*).

And as the bones are admirably adapted to prop; ſo all the parts of the body are as incomparably placed to poiſe it. Not one ſide too heavy for the other; but all in nice æquipoiſe: the ſhoulders, arms, and ſide æquilabrated on one part, on the other part of the viſcera of the belly counterpois'd with the weight of the ſcapular part, and that uſeful cuſhion of fleſh behind.

And laſtly, to all this we may add the wonderful concurrence, and miniſtry, of the prodigious number and variety of muſcles, placed throughout the body for this ſervice; that they ſhould ſo readily anſwer to every poſture, and comply with every motion thereof, without any previous thought or reflex act, ſo that (as the excellent *Borelli* (*k*) ſaith) 'It is worthy 'of admiration, that in ſo great a variety of 'motions, as running, leaping, and dancing, 'nature's laws of æquilibration ſhould always 'be obſerv'd; and when neglected, or wil'fully tranſgreſſed, that the body muſt ne'ceſſarily and immediately tumble down.'

(*i*) It is very well worth while to compare here what *Borelli* ſaith, *de motu animal. part.* 1. *cap.* 18. *De ſtatione animal. prop.* 132, *&c.* To which I refer the reader, it being too long to recite here.

(*k*) Borel. *ibid. prop.* 142.

CHAP. III.

Of the Figure and Shape of Man's Body.

THE figure and ſhape of man's body, is the moſt commodious that could poſſibly be invented for ſuch an animal; the moſt agreeable to his motions, to his labours, and all his occaſions. For had he been a rational reptile, he could not have moved from place to place faſt enough for his buſineſs, nor indeed have done any almoſt. Had he been a rational quadrupede, among other things, he had loſt the benefit of his hands, thoſe noble inſtruments of the moſt uſeful performances of the body. Had he been made a bird, beſides many other great inconveniencies, thoſe before-mentioned of his flying would have been ſome. In a word, any other ſhape of body, but that which the all-wiſe Creator hath given man, would have been as incommodious, as any poſture but that of erect; it would have rendered him more helpleſs, or have put it in his power to have been more pernicious, or depriv'd him of ten thouſand benefits, or pleaſures, or conveniencies, which his preſent figure capacitates him for.

CHAP. IV.

Of the Stature and Size of Man's Body.

AS in the figure, ſo in the ſtature and ſize of man's body, we have another manifeſt indication of excellent deſign. Not too pygmean (*a*), nor too gigantick (*b*); either of which ſizes would, in ſome particular or other, have been incommodious to himſelf, or to his buſineſs, or to the reſt of his fellow-creatures. Too pygmean would have rendered him too puny a lord of the creation: too impotent, and unfit to manage the inferior creatures; would have expoſed him to the aſſaults of the weakeſt animals, to the ravening appetite of voracious birds, and have put him in the way, and endangered his being trodden in the dirt by the larger animals. He would have been alſo too weak for his buſineſs, unable to carry burdens; and, in a word, to tranſact the greater part of his labours and concerns.

(*a*) What is here urged about the ſize of man's body, may anſwer one of *Lucretius*'s reaſons, why 'Nil ex nihilo gignitur.' His argument is,

Denique cur homines tantos natura parare
Non potuit, pedibus qui pontum per vada poſſent
Tranſire, & magnos manibus divellere monteis?

Lucret. *l.* 1. carm. 230.

(*b*) 'Haud facile fit ut quiſquam & ingentes corporis vires, & ingenium ſubtile habeat.' Diodor. Sic. *l.* 17.

And on the other hand, had man's body been made too monſtrouſly ſtrong, too enormouſly gigantick (*c*), it would have rendered him

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(*c*) Although we read of giants before *Noah*'s flood, *Gen.* vi. 4. and more plainly afterwards in *Numb* xiii. 33. yet there is great reaſon to think the ſize of man was always the ſame from the creation. For as to the *Nephilim*, or giants, in *Gen.* vi. the ancients vary about them; ſome taking them for great atheiſts, and monſters of impiety, rapine, tyranny, and all wickedneſs, as well as of monſtrous ſtature, according as indeed the *Hebrew* ſignification allows.

And as for the *Nephilim* in *Numb.* xiii. which were evidently men of a gigantic ſize, it muſt be conſidered, that it is very probable, the fears and diſcontentments of the ſpies might add ſomewhat thereunto.

But be the matter as it will, it is very manifeſt, that in both theſe places, giants are ſpoken of as rarities and wonders of the age, not of the common ſtature. And ſuch inſtances we have had in all ages; excepting ſome fabulous relations; ſuch as I take to be that of *Theutobocchus*, who is ſaid to have been dug up, *anno* 1613, and to have been higher than the trophies, and 26 feet long; and no better I ſuppoſe the giants to have been that *Ol. Magnus* gives an account of, in his 5th book, ſuch as *Harthen*, and *Starchater*, among the men; and among the women, 'Reperta eſt (ſaith he) puella----in capite vulnerata, ac mortua, induta chlamyde purpureâ, longitudinis cubitorum 50, latitudinis inter humeros quatuor.' *Ol. Mag. hiſt. l.* 5. *c.* 2.

But

him a dangerous tyrant in the world, too
ſtrong

But as for the more credible relations of *Goliah* (whoſe height was 6 cubits and a ſpan,' 1 *Sam.* xvii. 4. which, according to the late curious and learned Lord biſhop of *Peterborough*, is ſomewhat above 11 feet *Engliſh*; vid. *Biſhop* Cumberland *of Jewiſh weights and meaſures*) of *Maximinus* the emperor, who was 9 feet high, and others in *Auguſtus*, and other reigns, of about the ſame height: To which we may add, the dimenſions of a Skeleton, dug up lately in the place of a *Roman* camp near St. *Albans*, by an urn, inſcribed *Marcus Antoninus*; of which an account is given by Mr. *Cheſelden*, who judgeth, by the dimenſions of the bones, that the perſon was 8 feet high. *Vide Phil. Tranſ.* N° 333. Theſe antique examples and relations, I ſay, we can match, yea, out-do, with modern examples: of which we have divers in *J. Ludolph. Comment. in hiſt. Æthiop. l.* 1. *c.* 2. §. 22. *Magus*, *Couringius*, Dr. *Hakewill*, and others. Which latter relates from *Nannez*, of porters and archers belonging to the emperor of *China*, of 15 feet high; and others from *Purchas*, of 10 and 12 feet high; and more. See the learned author's *Apolog.* p. 208.

Theſe indeed exceed what I have ſeen in *England*; but in 1684, I myſelf meaſured an *Iriſh* youth, ſaid to be not 19 years old, who was 7 feet and near 8 inches; and in 1697, a woman who was 7 feet 3 inches in height.

But for the ordinary ſize of mankind, in all probability, it was always (as I ſaid) the ſame, as may appear from the monuments, mummies, and other ancient evidences to be ſeen at this day. The
moſt

moſt ancient monument at this day, I preſume, is that of *Cheops*, in the firſt and faireſt pyramid of *Egypt*; which was, no doubt, made of capacity every way ſufficient to hold the body of ſo great a perſon as was intended to be laid up in it: But this we find, by the nice meaſures of our curious Mr. *Greaves*, hardly to exceed our common coffins. ‘The hollow part within (ſaith he) is in length only 6,488 feet, and in breadth but 2,218 feet: The depth 2,860 feet. A narrow ſpace, yet large enough to contain a moſt potent and dreadful monarch, being dead; to whom living, all *Egypt* was too ſtreight and narrow a circuit. By theſe dimenſions, and by ſuch other obſervations, as have been taken by me from ſeveral embalmed bodies in *Egypt*, we may conclude there is no decay in nature (though the queſtion is as old as *Homer*) but that the men of this age are of the ſame ſtature they were near 3000 years ago.’ *Vide Greaves of the pyram. in* 1638, in *Ray*'*s collect. of trav. tom.* 1. *p.* 118.

To this more ancient, we may add others of a later date. Of which take theſe, among others, from the curious and learned *Hakewill*. The tombs at *Piſa*, that are ſome thouſand years old, are not longer than ours; ſo is *Athelſtane*'s in *Malmſbury* church; ſo *Sebba*'s in St. *Paul*'s, of the year 693; ſo *Etheldred*'s, &c. Apol. 216, *&c.*

The ſame evidence we have alſo from the armour, ſhields, veſſels, and other utenſils dug up at this day. The braſs helmet dug up at *Metaurum*, which was not doubted to have been left there at the overthrow of *Aſdrubal*, will fit one of our men at this day.

Nay, beſides all this, probably we have ſome more certain evidence. *Auguſtus* was 5 feet 9 inches ſtrong (*d*), in ſome reſpects, even for his own kind, as well as the other creatures. Locks and

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ches high, which was the juſt meaſure of our famous Queen *Elizabeth*, who exceeded his height 2 inches, if proper allowance be made for the difference between the *Roman* and our foot. *Vide Hakewill, ib. p.* 215.

(*d*) To the ſtature of men in the foregoing note, we may add ſome remarks about their unuſual ſtrength. That of *Sampſon* (who is not ſaid to have exceeded other men in ſtature, as he did in ſtrength) is well known. So of old, *Hector*, *Diomedes*, *Hercules*, and *Ajax*, are famed; and ſince them many others; for which I ſhall ſeek no farther than the before commended *Hakewill*, who by his great and curious learning, hath often moſt of the examples that are to be met with, on all his ſubjects he undertakes. Of the after-ages he names *C. Marius*, *Maximinus*, *Aurelian*, *Scanderbeg*, *Bardeſin*, *Tamerlane*, *Ziſka*, and *Hunniades*. Anno 1529, *Klunber*, provoſt of the great church at *Miſnia*, carried a pipe of wine out of the cellar, and laid it in the cart. *Mayolus* ſaw one hold a marble pillar in his hand 3 feet long, and one foot diameter, which he toſs'd up in the air, and catched again, at if it were a ball. Another at *Mantua*, and a little man, named *Rodamas*, could break a cable, &c. *Ernando Burg* fetched up ſtairs an aſs laden with wood, and threw both into the fire. At *Conſtantinople*, *anno* 1582, one lifted a piece of wood that twelve men could ſcarce raiſe; then lying along, he bare a ſtone that ten men could but juſt roll to him. *G.* of *Fronſberge*, baron of *Mindlehaim*, could raiſe a man off his ſeat, with only his middle finger; ſtop an horſe in his full career, and ſhove a cannon and doors might perhaps have been made of ſufficient ſtrength to have barricaded our houſes; and walls and ramparts might perhaps have been made ſtrong enough to have fenced our cities. But theſe things could not have been without a great and inconvenient expence of room, materials, and ſuch neceſſaries, as ſuch vaſt ſtructures and uſes would have occaſioned; more, perhaps, than the world could have afforded to all ages and places. But let us take the deſcant of a good naturaliſt and phyſician on the caſe (*e*). ‘ Had man been a ‘ dwarf

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cannon out of its place. *Cardan* ſaw a man dance with two men in his arms, two on his ſhoulders, and one on his neck. *Patacoua*, captain of the *Coſſacks*, could tear an horſe-ſhoe (and, if I miſtake not, the ſame is reported of the late King *Auguſtus* of *Poland*.) A gigantic woman of the *Netherlands* could lift a barrel of *Hamburg* beer. Mr. *Carew* had a tenant that could carry a butt's length, 6 buſhels of wheaten meal (of 15 gallons meaſure) with the lubber the miller, of 24 years of age, on the top of it. And *J. Roman*, of the ſame county, could carry an ox. *Vide Hakewill, ibid. p.* 238.

‘ Viros aliquot moderna memoria tam à mineralibus, quàm aliis Suethiæ & Gothiæ provinciis ‘ adducere congruit, tantâ fortitudine præditos, ut ‘ quiſque eorum in humeros ſublevatum equum, ‘ vel bovem maximum, imò vas ferri 600, 800, ‘ aut 1000 librarum (quale & aliquæ puellæ levare ‘ poſſunt) ad plura ſtadia portaret.’ *Ol. Mag. ubi ſupra.*

(*e*) Grew's *Coſmol. Sacr. book* i. *chap* 5. § 25.

dwarf (ſaid he) he had ſcarce been a reaſonable creature: for he muſt then have had a jolt head; ſo there would not have been body and blood enough to ſupply his brain with ſpirits; or he muſt have had a ſmall head anſwerable to his body, and ſo there would not have been brain enough for his buſineſs.—Or had the ſpecies of mankind been gigantick, he could not have been ſo commodiouſly ſupplied with food: For there would not have been fleſh enough of the beſt edible beaſts to ſerve his turn. And if beaſts had been made anſwerably bigger, there would not have been graſs enough.’ And ſo he goeth on. And a little after, ‘There would not have been the ſame uſe and diſcovery of his reaſon; in that he would have done many things by meer ſtrength, for which he is now put to invent innumerable engines.—Neither could he have uſed an horſe, nor divers other creatures: But being of a middle bulk, he is fitted to manage and uſe them all. For (ſaith he) no other cauſe can be aſſigned, why a man was not made five or ten times bigger, but his relation to the reſt of the univerſe.’ Thus far our curious author.

CHAP. V.

Of the Structure of the Parts of Man's Body.

HAVING thus taken a view of the poſture, ſhape, and ſize of man's body, let us in this chapter ſurvey the ſtructure of its parts. But here we have ſo large a proſpect, that it would be endleſs to proceed upon particulars. It muſt ſuffice therefore to take notice, in general only, how artificially every part of our body is made. No botch, no blunder, no unneceſſary apparatus (or in other words) no ſigns of chance (*a*); but every thing curious, orderly, and performed in the ſhorteſt and beſt method, and adapted to the moſt compendious uſe. What one part is there

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(*a*) It is manifeſtly an argument of deſign, That in the bodies of different animals, there is an agreement of the parts, ſo far as the occaſions and offices agree; but a difference of thoſe, where there is a difference of theſe. In a human body are many parts agreeing with thoſe of a dog, for inſtance; but in his forehead, fingers, hands, inſtruments of ſpeech, and many other parts, there are muſcles, and other members which are not in a dog. And ſo contrary-wiſe in a dog, which is not in a man. If the reader is minded to ſee what particular muſcles are in a man, that are not in a dog; or in a dog that are not in an human body, let him conſult the curious and accurate anatomiſt, Dr. *Douglaſs*'s *Myogr. compar.*

ere throughout the whole body, but what compoſed of the fitteſt matter for that part ; ade of the moſt proper ſtrength and texture ; aped in the compleateſt form ; and, in a ord, accoutered with every thing neceſſary r its motion, office, nouriſhment, guard, and hat not ! What ſo commodious a ſtructure d texture could have been given to the ones, for inſtance, to make them firm and rong, and withal light, as that which every one in the body hath ? who could have ſhaped em ſo nicely to every uſe, and adapted them every part, made them of ſuch juſt lengths, iven them ſuch due ſizes and ſhapes, chan- elled, hollowed, headed, lubricated, and very other thing miniſtring, in the beſt and oſt compendious manner, to their ſeveral laces and uſes ? what a glorious collection d combination have we alſo of the moſt ex- uiſite workmanſhip and contrivance in the ye, in the ear, in the hand (*b*), in the foot (*c*), in

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(*b*) *Galen* having deſcribed the muſcles, tendons, d other parts of the fingers, and their motions, ies out, 'Conſidera igitur etiam hic mirabilem Creatoris ſapientiam !' *De uſ. part. l.* 1. *c.* 18.

(*c*) And not only in the hand, but in his account the foot (*l.* 3.) he frequently takes notice of hat he calls, 'Artem, providentiam & ſapientiam conditoris.' As *chap.* 13. 'An igitur non æquum eſt hic quoque admirari providentiam conditoris, qui ad utrumque uſum, etſi certè contrarium, exactè convenientes & conſentientes invi-

'cem

in the lungs, and other parts already mentioned? what an abridgment of art, what a variety of uſes (*d*), hath nature laid upon that one member the tongue, the grand inſtrument of taſte, the faithful judge, the centinel, the watchman of all our nouriſhment, the artful modulator of our voice, the neceſſary ſervant of maſtication, ſwallowing, ſucking, and a great deal beſides? But I muſt deſiſt from proceeding upon particulars, finding I am fallen upon what I propoſed to avoid.

And therefore, for a cloſe of this chapter, I ſhall only add part of a letter I received from the before-commended very curious and ingenious phyſician Dr. *Tancred Robinſon*. 'What (ſaith he) can poſſibly be better contrived

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'cem fabricatus eſt totius membri [tibiæ] particulas?' And at the end of the chap. 'Quòd ſi omnia quæ ipſarum ſunt partium mente immutaverimus, neque invenerimus poſitionem aliam meliorem eâ quam nunc ſortita ſunt, neque figuram, neque magnitudinem, neque connexionem, neque (ut paucis omnia complectar) aliud quidquam eorum, quæ corporibus neceſſariò inſunt: perfectiſſimam pronunciare oportet, & undique rectè conſtitutam præſentem ejus conſtructionem.' The like alſo concludes chap. 15.

(*d*) 'At enim opificis induſtrii maximum eſt indicium (quemadmodum antè ſæpenumerò jam diximus) iis quæ ad alium uſum fuerunt comparata, ad alias quoque utilitates abuti, neque laborare ut ſingulis utilitatibus ſingulas faciat proprias particulas.' *Galen ubi ſupra, l.* 9. *c.* 5.

‘trived ſor animal motion and life, than the quick circulation of the blood and fluids, which run out of ſight in capillary veſſels, and very minute ducts, without impediment (except in ſome diſeaſes) being all directed to their peculiar glands and channels, for the different ſecretion, ſenſible and inſenſible; whereof the laſt is far the greateſt in quantity and effects, as to health and ſickneſs, acute diſtempers frequently ariſing from a diminution of tranſpiration, thro' the cutaneous chimneys, and ſome chronicle ones, from an augmentation: whereas obſtructions in the liver, pancreas, and other glands, may only cauſe a ſchirrus, a jaundice, an ague, a dropſy, or other ſlow diſeaſes. So an increaſe of that ſecretion may accompany the general colliquations, as in fluxes, hectick ſweats and coughs, diabetes, and other conſumptions. What a mighty contrivance is there to preſerve theſe due ſecretions from the blood (on which life ſo much depends) by frequent attritions, and communications of the fluids in their paſſage through the heart, the lungs, and the whole ſyſtem of the muſcles? What meanders and contortions of veſſels, in the organs of ſeparation? and, what a concourſe of elaſtick bodies from the air, to ſupply the ſprings, and continual motions of ſome parts, not only in ſleep and reſt; but in long violent exerciſes of the muſcles? whoſe force drives

‘ the fluids round, in a wonderful rapid cir-
‘ culation, through the minuteſt tubes, aſſiſted
‘ by the conſtant pabulum of the atmoſphere,
‘ and their own elaſtick fibres, which impreſs
‘ that velocity on the fluids.

‘ Now I have mentioned ſome uſes of the
‘ air, in carrying on ſeveral functions in ani-
‘ mal bodies; I may add the ſhare it hath in
‘ all the digeſtions of the ſolid and fluid parts.
‘ For when this ſyſtem of air comes, by divine
‘ permittance, to be corrupted with poiſonous,
‘ acrimonious ſteams, either from the earth,
‘ from merchandiſe, or infected bodies, what
‘ havock is made in all the operations of liv-
‘ ing creatures? the parts gangrene, and mor-
‘ tify under carbuncles, and other tokens:
‘ Indeed, the whole animal oeconomy is
‘ ruined; of ſuch importance is the air to all
‘ the parts of it.’ Thus my learned friend.

C H A P. VI.

Of the Placing the parts of Man's Body.

IN this chapter I propoſe to conſider the lodgment of the curious parts of man's body, which is no leſs admirable than the parts themſelves, all ſet in the moſt convenient places of the body, to miniſter to their own ſeveral uſes and purpoſes, and aſſiſt, and mutually to help one another. Where could thoſe faithful watchmen the eye, the ear, the tongue,

tongue, be ſo commodiouſly placed, as in the upper part of the building? where could we, throughout the body, find ſo proper a part to lodge four of the five ſenſes, as in the head (*a*), near the brain (*b*), the common ſenſory, a place well guarded, and of little other uſe than to be a ſeat to thoſe ſenſes? And, how could we lodge the fifth ſenſe, that of touching, otherwiſe (*c*), than to diſperſe it to all parts of the body? where could we plant the hand (*d*), but

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(*a*) 'Senſus, interpretes ac nuntii rerum, in capite, tanquam in arce, mirificè ad uſus neceſſarios & facti, & collocati ſunt. Nam oculi tanquam ſpeculatores, altiſſimum locum obtinent; ex quo plurima conſpicientes, fungantur ſuo munere. Et aures cum ſonum recipere debeant, qui naturâ in ſublime fertur; rectè in illis corporum partibus collocatæ ſunt.' *Cic. de Nat. Deor. l.* 2. *c.* 56. *ubi plura de cæteris ſenſibus.*

(*b*) *Galen* well obſerves, That the nerves miniſtring to motion are hard and firm, to be leſs ſubject to injury; but thoſe miniſtring to ſenſe are ſoft and tender; and that for this reaſon it is, that four of the five ſenſes are lodged ſo near the brain; *viz.* partly to partake of the brain's ſoftneſs and tenderneſs, and partly for the ſake of the ſtrong guard of the ſkull. *Vide Gal. de Uſ. Part. l.* 8. *c.* 5, 6.

(*c*) See *book* iv. *chap.* 6. *note* (*c*).

(*d*) 'Quàm verò aptas, quamque multarum artium miniſtras manus natura homini dedit?' The particulars of which enumerated by him, ſee in *Cic. ubi ſupra, c.* 60.

but juſt where it is, to be ready at every turn, on all occaſions of help and defence, of motion, action, and every of its uſeful ſervices? where could we ſet the legs and feet, but where they are, to bear up, and handſomely to carry about the body? where could we lodge the heart, to labour about the whole maſs of blood, but in, or near the center of the body? where could we find room for that noble engine to play freely in? where could we ſo well guard it againſt external harms, as it is in that very place in which it is lodged and ſecured? where could we more commodiouſly place, than in the thorax and belly, the uſeful viſcera of thoſe parts, ſo as not to ſwag, and jog, and over-ſet the body, and yet to miniſter ſo harmoniouſly, as they do, to all the ſeveral uſes of concoction, ſanguification, the ſeparation of various ferments from the blood, for the great uſes of nature, and to make diſcharges of what is uſeleſs, or would be burthenſome or pernicious to the body (*f*)? how could we plant the curious and great variety of bones, and of muſcles, of all ſorts and ſizes, neceſſary, as I have ſaid, to the ſupport, and every motion of the body? where could we lodge all the arteries and veins, to convey

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(*e*) See *book* vi. *chap.* 5.

(*f*) 'Ut in ædificiis architecti avertunt ab oculis & naribus dominorum ea, quæ profluentia neceſſariò tetri eſſent aliquid habitura; ſic natura res ſimiles (ſcil. excrementa) procul amandavit a ſenſibus.' *Cic. de Nat. Deor. l.* 2. *c.* 56.

convey nouriſhment; and the nerves, ſenſation throughout the body? where, I ſay, could we lodge all theſe implements of the body, to perform their ſeveral offices? how could we ſecure and guard them ſo well, as in the very places, and in the ſelf-ſame manner in which they are already placed in the body? and laſtly, to name no more, what covering, what fence could we find out for the whole body, better than that of nature's own providing, the ſkin (*g*)? how could we ſhape it to, or brace it about every part better, either for convenience or ornament? what better texture could we give it, which although leſs obdurate and firm, than that of ſome other animals; yet is ſo much the more ſenſible of every touch, and more compliant with every motion? and being eaſily defenſible by the power of man's reaſon and art, is therefore much the propereſt tegument for a reaſonable creature.

(*g*) Compare here *Galen*'s obſervations *de Uſ. Part. l.* 11, *c.* 15. Alſo *l.* 2. *c.* 6. See alſo *Cowper, Anat.* where in *Tab.* 15. are very elegant cuts of the ſkin in divers parts of the body, drawn from microſcopical views; as alſo of the *papillæ pyramidales*, the ſudoriferous glands and veſſels, the hairs, &c.

CHAP. VII.

Of the Proviſion in Man's body againſt Evils.

HAVING taken a tranſient view of the ſtructure and lodgment of the parts of human bodies, let us next conſider the admirable proviſion that is made throughout man's body, to ſtave off evils, and to diſcharge (*a*) them when befallen. For the prevention of evils, we may take the inſtances already given, of the ſituation of thoſe faithful centinels, the eye, the ear, and tongue, in the ſuperior part of the body, the better to deſcry dangers at a diſtance, and to call out preſently for help. And how well ſituated is the hand to be a ſure and ready guard to the body, as well as the faithful performer of moſt of its ſervices? the brain, the nerves, the arteries, the heart (*b*), lungs;

(*a*) One of nature's moſt conſtant methods here, is by the glands, and the ſecretions made by them; the particulars of which being too long for theſe notes, I ſhall refer to the modern anatomiſts, who have written on theſe ſubjects; and indeed who are the only men that have done it tolerably: Particularly our learned doctors *Cockburn*, *Keil*, *Morland*, and others at home and abroad: An abridgment of whoſe opinions and obſervations, for the reader's eaſe, may be met with in Dr. Harris's *Lex. Tech. vol.* II. under the words Glands, and Animal Secretion.

(*b*) In man, and moſt other animals, the heart hath the guard of bones; but in the Lamprey, which ungs; and in a word, all the principal parts, how well are they barricaded, either with trong bones, or deep lodgments in the fleſh, r ſome ſuch the wiſeſt and fitteſt method, moſt greeable to the office and action of the part? Beſides which, for greater precaution, and a arther ſecurity, what an incomparable proviion hath the infinite contriver of man's body nade for the loſs of, or any defect in, ſome of he parts we can leaſt ſpare, by doubling hem? by giving us two eyes, two ears, two ands, two kidneys, two lobes of the lungs, airs of the nerves, and many ramifications of he arteries and veins in the fleſhy parts, that here may not be a defect of nouriſhment of he parts, in caſes of amputation, or wounds, r ruptures of any of the veſſels.

And as man's body is admirably contriv'd, nd made to prevent evils; ſo no leſs art and aution hath been uſed to get rid of them hen they do happen. When by any miſortune, wounds or hurts do befal; or, when y our own wicked fooleries and vices, we ull down diſeaſes and miſchiefs upon ourelves, what emunctories (c), what admirable paſ-

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hich hath no bones (no not ſo much as a backone) 'the heart is very ſtrangely ſecured, and lies 'immur'd, or capſulated in a cartilage, or griſtly 'ſubſtance, which includes the heart, and its au'ricle, as the ſkull doth the brain in other ani'mals.' Power's *Microſ. Obſ.* 22.

(c) 'Here [from the puſtules he obſerved in *Monomotapa*] were grounds to admire the contri-
'vance

paſſages (*d*), are diſpers'd throughout the body; what incomparable methods doth nature take (*e*); what vigorous efforts is ſhe enabled

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‘ vance of our blood, which on ſome occaſions,
‘ ſo ſoon as any thing deſtructive to the conſtitu-
‘ tion of it comes into it, immediately, by an in-
‘ teſtine commotion, endeavoureth to thruſt it forth,
‘ and is not only freed from the new gueſt, but
‘ ſometimes what likewiſe may have lain lurking
‘ therein-----for a great while. And from hence
‘ it comes to paſs, That moſt part of medicines,
‘ when duly adminiſtred, are not only ſent out of
‘ the body themſelves, but likewiſe great quanti-
‘ ties of morbifick matter: As in ſalivation, &c.’
Dr. Sloane's voy. to *Jamaica*, *p.* 25.

(*d*) *Valſalva* diſcover'd ſome paſſages into the region of the Ear-drum, of mighty uſe (among others) to make diſcharges of bruiſes, impoſthumes, or any purulent, or morbifick matter from the brain, and parts of the head. Of which he gives two examples: One a perſon, who from a blow on his head, had diſmal pains therein, grew ſpeechleſs, and lay under an abſolute ſuppreſſion and decay of his ſtrength; but found certain relief, whenever he had a flux of blood, or purulent matter out of his ear; which after his death *Valſalva* diſcovered, was through thoſe paſſages.

The other was an apoplectical caſe, wherein he found a large quantity of extravaſated blood, making way from the ventricles of the brain, through thoſe ſame paſſages. Valſal. *de aure hum.* *c.* 2. § 14. and *c.* 5. § 8.

(*e*) *Hippocrates*, *lib. de alimentis*, takes notice of the ſagacity of nature in finding out methods and paſſages

nabled to make, to diſcharge the peccant hu-
nour, to correct the morbifick matter; and,
n a word, to ſet all things right again? But
ere we had beſt take the advice of a learned
physician

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aſſages for the diſcharging things offenſive to the
ody; of which the late learned and ingenious
iſhop of *Clogher* in *Ireland* (*Boyle*) gave this re-
arkable inſtance, to my very curious and inge-
ious neighbour and friend, *D'Acre Barret*, Eſq;
iz. That in the plague-year, a gentleman at the
niverſity had a large plague-ſore gathered under
is arm, which, when they expected it would have
roken, diſcharged itſelf by a more than ordinary
arge and fœtid ſtool; the ſore having no other
ent for it, and immediately becoming ſound and
ell thereon.

Like to which, is the ſtory of *Joſeph Lazonius*, of
a ſoldier of thirty-five years of age, who had a
welling in his right hip, accompanied with great
ain, &c. By the uſe of emollient medicines, hav-
ng ripened the ſore, the ſurgeon intended the next
ay to have opened it; but about midnight, the
atient having great provocations to ſtool, diſbur-
hen'd himſelf three times; immediately upon
which, both the tumour and pain ceaſed, and
thereby diſappointed the ſurgeon's intentions. *E-
phem. Germ. Anno* 1690. *Obſ.* 49. More ſuch in-
ſtances we find of Mr. *Tonge*'s, in *Philoſ. Tranſ.* N°
323. But indeed there are ſo many examples of
this nature in our *Philoſ. Tranſact.* in *Ephem. Ger-
man. Tho. Bartholine*, *Rhodius*, *Sennertus*, *Hildanus*,
&c. that it would be endleſs to recount them.
Some have ſwallowed knives, bodkins, needles and
pins, bullets, pebbles, and twenty other ſuch things
as

phyſician in the caſe: ‘ The body (ſaith he) ‘ is ſo contrived, as to be well enough ſecured againſt the mutations in the air, and ‘ the leſſer errors we daily run upon: did we ‘ not in the exceſſes of eating, drinking, thinking, loving, hating, or ſome other folly, ‘ let in the enemy, or lay violent hands upon ‘ ourſelves. Nor is the body fitted only to ‘ prevent, but alſo to cure, or mitigate diſeaſes, when by theſe follies brought upon ‘ us. In moſt wounds, if kept clean, and ‘ from the air,——the fleſh will glue together with its own native balm. Broken ‘ bones are cemented with the Callus, which ‘ themſelves help to make.’ And ſo he goes on with ample inſtances in this matter, too

many

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as could not find a paſſage the ordinary way, but have met with an exit through the bladder, or ſome other way of nature's own providing. But paſſing over many particulars, I ſhall only give one inſtance more, becauſe it may be a good caution to ſome perſons, that theſe papers may probably fall into the hands of; and that is, the danger of ſwallowing plumb-ſtones, prune-ſtones, *&c.* Sir *Francis Butler*'s lady had many prune-ſtones that made way through an abſceſs near her navel, *Phil. Tranſ.* N° 265. where are many other ſuch like examples. More alſo may be found in N° 282, 304, *&c.* And at this day, a young man, living not far off me, laboureth under very troubleſome and dangerous ſymptoms, from the ſtones of ſloes and bullace, which he ſwallow'd eight or ten years ago.

nany to be here ſpecify'd (*f*). Among which e inſtanceth in the diſtempers of our bodies, hewing, that even many of them are highly erviceable to the diſcharge of malignant humours, and preventing greater evils.

And no leſs kind than admirable is this conrivance of man's body, that even its diſtemers ſhould many times be its cure (*g*); that when

(*f*) Grew's *Coſmol.* § 28, 29.

(*g*) 'Nor are diſeaſes themſelves uſeleſs: For the blood in a fever, if well governed, like wine upon the fret, diſchargeth itſelf of all heterogeneous mixtures; and nature, the diſeaſe, and remedies, clean all the rooms of the houſe; whereby that which threatens death, tends, in concluſion, to the prolonging of life.' Grew, *ubi ſupr.* 52.

And as diſeaſes miniſter ſometimes to health; ſo o other good uſes in the body, ſuch as quickening he ſenſes: Of which take theſe inſtances relating o the hearing and ſight.

'A very ingenious phyſician falling into an odd kind of fever, had his ſenſe of hearing thereby made ſo very nice and tender, that he very plainly heard ſoft whiſpers, that were made at a conſiderable diſtance off, and which were not in the leaſt perceiv'd by the by-ſtanders, nor would have been by him before his ſickneſs.'

'A gentleman of eminent parts and note, during a diſtemper he had in his eyes, had his organs of ſight brought to be ſo tender, that both his friends and himſelf have aſſured me, That when he wak'd in the night, he cou'd, for a while, plainly ſee and diſtinguiſh colours, as 'well when the enemy lies lurking within to deſtroy us, there ſhould be ſuch a reluctancy, and al nature excited with its utmoſt vigour to expel him thence. To which purpoſe, even pain itſelf is of great and excellent uſe, not only i giving us notice of the preſence of the enemy, but by exciting us to uſe our utmoſt diligence and ſkill to root out ſo troubleſome and deſtructive a companion.

C H A P. VIII.

Of the Conſent between the Parts of Man's Body.

IT is an admirable proviſion the merciful Creator hath made for the good of man's body, by the conſent and harmony between the parts thereof: of which let us take St. *Paul*'s deſcription, in 1 *Cor*. xii. 8. ‘But now ‘hath God ſet the members every one of them ‘in the body, as it hath pleaſed him.’ And ver. 21. ‘The eye cannot ſay unto the hand, I ‘have

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‘well as other objects, diſcernible by the eye, ‘as was more than once try'd.’ Boyl. *deter. nat. of Effluv. ch.* 4.

‘*Daniel Fraſer*----continu'd deaf and dumb from ‘his birth, 'till the 17th year of his age----After ‘his recovery from a fever, he perceiv'd a motion ‘in his brain, which was very uneaſy to him; ‘and afterwards he began to hear, and, in proceſs ‘of time, to underſtand ſpeech, &c.’ *Vid. Phil. Tranſ.* N° 312.

have no need of thee: nor again, the head to the feet, I have no need of you.’ But ſuch is the conſent of all the parts, or as the Apoſtle wordeth it, ‘God hath ſo tempered the body together, that the members ſhould have the ſame care one for another,’ ver. 25. So that ‘whether one member ſuffer, all the members ſuffer with it; or one member be honoured (or affected with any good) all the members rejoice [and ſympathize] with it.’ ver. 26.

This mutual accord, conſent, and ſympathy of the members, there is no reaſon to doubt (*a*), is made by the commerce of the nerves (*b*), and their artificial poſitions, and curious ramifications throughout the whole body, which is admirable and incomparable, and might deſerve a place in this ſurvey, as greatly

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(*a*) See *book* iv. *chap*. 8.

(*b*) ‘Tria propoſita ipſi naturæ in nervorum diſtributione fuerunt. 1. Ut ſenſoriis inſtrumentis ſenſum impertiret. 2. Ut motoriis motum. 3. Ut omnibus aliis [partibus] daret ut quæ, ſi dolorem adferrent, dignoſcerent.’ And afterwards, ‘Si quis in diſſectionibus ſpectavit, conſideravitque juſténe an ſecus natura nervos non eâdem menſurâ omnibus partibus diſtribuerit, ſed aliis quidem liberaliùs, aliis verò parciùs, eadem cum Hippocrate, velit nolit, de naturâ omnino pronunciabit, quod ea ſcilicet ſagax, juſta, artificioſa, animaliumque provida eſt.’ Galen. *de uſu part. l.* 5. *c.* 9.

greatly and manifeſtly ſetting forth the wiſdom and benignity of the great Creator; but that to give a deſcription thereof from the origin of the nerves, in the brain, the Cerebellum and Spine, and ſo through every part of the body, would be tedious, and intrench too much upon the anatomiſt's province: And therefore one inſtance ſhall ſuffice for a ſample of the whole; and that ſhall be (what was promiſed before) (*c*), the great ſympathy occaſion'd by the fifth pair of nerves; which I chuſe to inſtance in, rather than the Par Vagum, or any other of the nerves; becauſe altho' we may have leſs variety of noble contrivance and art, than in that pair, yet we ſhall find enough for our purpoſe, and which may be diſpatch'd in fewer words. Now this fifth conjugation of nerves, is branch'd to the ball, the muſcles, and glands of the eye; to the ear; to the jaws, the gums, and teeth; to the muſcles of the lips (*d*); to the tonſils, the palate

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(*c*) *Book* iv. *chap.* 5.

(*d*) Dr. *Willis* gives the reaſon, ‘Cur mutua amaſiorum oſcula labiis impreſſa, tum præcordia, tum genitalia afficiendo, amorem ac libidinem tam facilè irritant,’ to be from the conſent of thoſe parts, by the branches of this fifth pair, *Nerv. Deſcr. c.* 22.

And Dr. *Sachs* judges it to be from the conſent of the *Labia oris cum labiis uteri*, that in *April* 1699, a certain breeding lady, being affrighted with ſeeing one that had ſcabby lips, which they told her were occaſioned by a peſtilential fever, had ſuch like puſtules broke out in the *labia uteri*. *Ephem. Germ. T.* 1. *Obſ.* 20.

palate, the tongue, and the parts of the mouth; to the Præcordia alſo, in ſome meaſure, by inoſculating with one of its nerves; and laſtly, to the muſcles of the face, particularly the cheeks, whoſe ſanguiferous veſſels it twiſts about.

From hence it comes to paſs, that there is a great conſent and ſympathy (*e*) between theſe parts; ſo that a guſtable thing ſeen or ſmelt, excites the appetite, and affects the glands and parts of the mouth; that a thing ſeen or heard, that is ſhameful, affects the cheeks with modeſt bluſhes; but, on the contrary, if it pleaſes and tickles the fancy, that it affects the Præcordia, and muſcles of the mouth and face with laughter; but a thing cauſing ſadneſs and melancholy, doth accordingly exert itſelf upon the Præcordia, and demonſtrate itſelf by cauſing the glands of the eyes to emit tears (*f*), and the muſcles of the face to put on the ſorrowful aſpect of crying. Hence alſo that torvous ſoure look produced by anger and hatred, and that gay and pleaſing countenance accompanying love and hope. And in ſhort, it

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(*e*) Conſult Willis *ubi ſupra.*

(*f*) Tears ſerve not only to moiſten the eye, to clean and brighten the *Cornea*, and to expreſs our grief; but alſo to alleviate it, according to that of *Ulyſſes* to *Andromache*, in Seneca's *Troas*, ver. 762.

Tempus moramque dabimus, arbitrio tuo
Implere lacrymis: Fletus ærumnas levat.

it is by means of this communication of the nerves, that whatever affects the ſoul, is demonſtrated (whether we will or no) by a conſentaneous diſpoſition of the Præcordia within, and a ſuitable configuration of the muſcles and parts of the face without. And an admirable contrivance of the great God of nature this is; That as a face is given to man, and, as *Pliny* ſaith (*g*), to man alone of all creatures; ſo it ſhould be (as he obſerves) 'the Index of ſorrow and chearfulneſs, of 'compaſſion and ſeverity. In its aſcending 'part is the brow, and therein a part of the 'mind too. Therewith we deny, therewith 'we conſent. With this it is we ſhew our 'pride, which hath its ſource in another 'place; but here its ſeat: In the heart it 'hath its birth; but here it abides and dwells; 'and that becauſe it could find no other part 'throughout the body higher, or more craggy (*h*), where it might reſide alone.'

Thus I have diſpatch'd what I ſhall remark concerning the ſoul and body of man. There are divers other things, which well deſerve a place in this ſurvey; and theſe that I have taken notice of deſerved to have been enlarged upon: but what hath been ſaid, may ſuffice for a taſte and ſample of this admirable piece of God's handy-work; at leaſt ſerve as a ſupplement to what others have ſaid before me.

For

(*g*) Plin. *Nat. Hiſt. l.* 11. *c.* 37.

(*h*) 'Nihil altius ſimul abruptiuſque invenit.'

For which reaſon I have endeavour'd to ſay as little wittingly as I could, of what they have taken notice of, except where the thread of my diſcourſe laid a neceſſity upon me.

CHAP. IX.

Of the Variety of Men's Faces, Voices, and Hand-writing.

HERE I would have put an end to my obſervations relating to man, but that there are three things ſo expreſly declaring the divine management and concurrence, that I ſhall juſt mention them, although taken notice of more amply by others; and that is, the great variety throughout the world, of men's faces (*a*), voices (*b*), and hand-writing.

Had

(*a*) If the reader hath a mind to ſee examples of men's likeneſs, he may conſult *Valer. Maximus, l.* 9. *c.* 14. concerning the likeneſs of *Pompey* the Great, and *Vibius*, and *Publicius Libertinus*; as alſo of *Pompey* the father, who got the name of *Coquus*, he being like *Menogenes* the cook; with divers others.

(*b*) As the difference of tone makes a difference between every man's voice, of the ſame country, yea, family, ſo a different dialect and pronunciation, differs perſons of divers countries, yea, perſons of one and the ſame country, ſpeaking the ſame language. Thus in *Greece*, there were the *Ionick, Dorick, Attick,* and *Æolick* dialects. So in

Great-

Had man's body been made according to any of the atheiſtical ſchemes, or any other method than that of the infinite Lord of the world, this wiſe variety would never have been: but mens faces would have been caſt in the ſame, or not a very different mould; their organs of ſpeech would have ſounded the ſame, or not ſo great a variety of notes; and the ſame ſtructure of muſcles and nerves, would have given the hand the ſame direction in writing. And in this caſe, what confuſion, what diſturbance, what miſchiefs, would the world eternally have lain under? no ſecurity could have been to our perſons; no certainty, no enjoyment of our poſſeſſions (*c*): no juſtice between

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Great-Britain, beſides the grand diverſity of *Engliſh* and *Scotch*, the different countries vary very much in their pronunciation, accent, and tone, altho' all one and the ſame language. And the way of the *Gileadites* proving the *Ephraimites*, *Judges* xii. 6. by the pronunciation of *Shibboleth*, with a *Schin*, or *Sibboleth* with a *Samech*, is well known. So *à Lapide* ſaith, the *Flemmings* prove whether a man be a *Frenchman* or not, by bidding him pronounce *Acht en tachtenticht*; which they pronounce *Acht en tactentic*, by reaſon they cannot pronounce the aſpirate *h*.

(*c*) ‘Regi Antiocho unus ex æqualibus------nomine Artemon, perquam ſimilis fuiſſe traditur. Quem Laodice, uxor Antiochi, interfecto viro, diſſimulandi ſceleris gratiâ, in lectulo perinde quaſi ipſum regem ægrum collocavit. Admiſſumque univerſum populum, & ſermone ejus & vultu conſimili fefellit: credideruntque homines ab Antiocho moriente Laodicen & natos ejus ſibi commendari.’ Val. Max. *ibid*.

between man and man; no diſtinction between good and bad, between friends and foes, between father and child, huſband and wife, male or female; but all would have been turned topſy-turvy, by being expoſed to the malice of the envious and ill-natured, to the fraud and violence of knaves and robbers, to the forgeries of the crafty cheat, to the luſt of the effeminate and debauched, and what not! our courts of juſtice (*d*) can abundantly teſtify the dire effects of miſtaking mens faces, of counterfeiting their hands, and forging writings. But now, as the infinitely wiſe Creator and ruler hath ordered the matter, every man's face can diſtinguiſh him in the light, and his voice in the dark; his hand-writing can ſpeak for him though abſent, and be his witneſs, and ſecure his contracts in future generations. A manifeſt, as well as admirable indication of the divine ſuperintendence and management (*e*).

(*d*) 'Quid Trebellius Calca! quam aſſeveranter ſeſe Clodium tulit! & quidem dum de bonis ejus contendit, in centumvirale judicium adeò favorabilis deſcendit, ut vix juſtis & æquis ſententiis conſternatio populi ullum relinqueret locum. In illâ tamen quæſtione neque calumniæ petitoris, neque violentiæ plebis judicantium religio ceſſit.' Val Max. *ibid.* *c.* 15.

(*e*) To the foregoing inſtances of divine management, with relation to the political ſtate of man, I ſhall add another thing, that I confeſs hath always ſeemed to me ſomewhat odd, but very providential; and that is, the value that mankind, at

leaſt

leaſt the civilized part of them, have in all ages put upon gems, and the purer finer metals, gold and ſilver; ſo as to think them equivalent unto, and exchange them for things of the greateſt uſe for food, cloathing, and all other neceſſaries and conveniencies of life. Whereas thoſe things themſelves are of very little, if any uſe, in phyſick, food building, or cloathing, otherwiſe than for ornament, or to miniſter to luxury; as *Suetonius* tells us of *Nero,* who fiſhed with a net gilt with gold, and ſhod his mules with ſilver; but his wife *Poppæa* ſhod her horſes with gold. *Vit. Ner. c.* 30. Plin. *N. H. l.* 33. *c.* 11. So the ſame *Suetonius* tells us, *Jul. Cæſar* lay in a bed of gold, and rode in a ſilver chariot. But *Heliogabalus* rode in one of gold, and had his cloſe-ſtool pans of the ſame metal. And *Pliny* ſaith, ‘Vaſa Coquinaria ex argento Calvus Orator fieri queritur.’ *Ibid.* Neither are thoſe precious things of greater uſe to the making of veſſels and utenſils (unleſs ſome little niceties and curioſities) by means of their beauty, imperdibility, and ductility. Of which laſt, the great Mr. *Boyle* hath, among others, theſe two inſtances, in his *Eſſay about the ſubtilty of effluviums, chap.* 2. ‘Silver, whoſe ductility and tractility are very much inferior to thoſe of gold, was, by my procuring, drawn out to ſo ſlender a wire, that----- a ſingle grain of it amounted to twenty-ſeven feet.’ As to gold, he demonſtrates it poſſible to extend an ounce thereof to reach 777600 feet, or 155 miles and an half; yea, to an incredibly greater length.

And as to gems, the very ſtories that are told of their prodigious virtues, are an argument that they have very little or none, more than other hard ſtones. That a Diamond ſhould diſcover whether a woman be true or falſe to her huſband's bed; cauſe love

between

between man and wife; ſecure againſt witchcraft, plague, and poiſons; that the Ruby ſhould diſpoſe to chearfulneſs, cauſe pleaſant dreams, change its colour againſt a misfortune befalling, &c. that the Sapphire ſhould grow foul, and loſe its beauty, when worn by one that is lecherous; that the Emerald ſhould fly to pieces, if it touch the ſkin of any unchaſte perſon in the act of uncleanneſs; that the Chryſolite ſhould loſe its colour, if poiſon be on the table, and recover it again when the poiſon is off; and, to name no more, that the Turcoiſe (and the ſame is ſaid of a gold ring) ſhould ſtrike the hour when hung over a drinking laſs; and much more to the ſame purpoſe: All heſe, and many other ſuch fabulous ſtories, I ſay, f gems, are great arguments that their virtue is quivalent to their value. Of theſe, and other irtues, conſult *Worm.* in his *Muſæum*, *l.* 1. § 2. . 17, *&c.*

But as to gems changing their colour, there nay be ſomewhat of truth in that, particularly n the Turcoiſe laſt-mentioned. Mr. *Boyle* oberved the ſpots in a Turcoiſe to ſhift their place rom one part to another, by gentle degrees. So id the cloud in an agate-handle of a knife. A iamond he wore on his finger, he obſerved to be ore illuſtrious at ſome times than others; which curious lady told him ſhe had alſo obſerved in hers, o likewiſe a rich Ruby did the ſame. *Boyle* of *bſol. reſt in bodies.*

CHAP.

CHAP. X.

The Concluſion of the Survey of Man.

AND now having taken a view of Man, and finding every part of him, every thing relating to him contrived, and made in the very beſt manner; his body fitted up with the utmoſt foreſight, art, and care; and this body (to the great honour, privilege, and benefit of man) poſſeſſed by a divine part, the Soul, a ſubſtance made as it were on purpoſe to contemplate the works of God, and glorify the great Creator; and ſince this ſoul can diſcern, think, reaſon, and ſpeak; what can we conclude upon the whole matter, but that we lie under all the obligations of duty and gratitude, to be thankful and obedient to, and to ſet forth the glories of our great Creator, and noble benefactor! and what ungrateful wretches are we, how much worſe than the poor irrationals, if we do not employ the utmoſt power of our tongue, and all our members, and all the faculties of our ſouls, in the praiſes of God! but above all, ſhould we, who have the benefit of thoſe glorious acts and contrivances of the Creator, be ſuch wicked, ſuch baſe, ſuch worſe than brutal fools, to deny the Creator (*a*), in ſome of his nobleſt works?

(*a*) It was a pious, as well as juſt concluſion, the ingenious *Laurence Bellini* makes of his *Opuſculum d* *mot* works? ſhould we ſo abuſe our reaſon, yea, our very ſenſes; ſhould we be ſo beſotted by the devil, and blinded by our luſts, as to attribute one of the beſt contrived pieces of workmanſhip to blind chance, or unguided matter and motion,

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motu cordis, in theſe words: ‘De motu cordis iſthæc. Quæ equidem omnia, ſi à rudi intelligentiâ hominis tantum conſilii, tantum ratiocinii, tantum peritiæ mille rerum, tantum ſcientiarum exigunt, ad hoc, ut inveniantur, ſeu ad hoc, ut percipiantur poſtquam facta ſunt; illum, cujus operâ fabrefacta ſunt hæc ſingula, tam vani erimus atque inanes, ut exiſtimemus eſſe conſilii impotem, rationis expertem, imperitum, aut ignarum omnium rerum? Quantum ad me attinet, nolim eſſe rationis compos, ſi tantum inſudandum mihi eſſet ad conſequendum intelligentiam earum rerum, quas fabrefaceret neſcio quæ vis, quæ nihil intelligeret eorum quæ fabrefaceret; mihi etenim viderer eſſe vile quiddam, atque ridiculum, qui vellem totam ætatem meam, ſanitatem, & quicquid humanum eſt deterere, nihil curare quicquid eſt jucunditatum, quicquid lætitiarum, quicquid commodorum; non divitias, non dignitates: non pœnas etiam, & vitam ipſam, ut gloriari poſſem poſtremò inveniſſe unum, aut alterum, & fortaſſe me inveniſſe quidem ex iis innumeris, quæ produxiſſet, neſcio quis ille, qui ſine labore, ſine curâ, nihil cogitans, nihil cognoſcens, non unam aut alteram rem, neque dubiè, ſed certò produxiſſet innumeras innumerabilitates rerum in hoc tam immenſo ſpatio corporum, ex quibus totus mundus compingitur. Ah Deum immortalem! video præſens numen tuum in hiſce tam prodigioſis generationis initiis, & in altiſſimâ

‘ eorum

motion, or any other ſottiſh, wretched, atheiſtical ſtuff; which we never ſaw, nor ever heard made any one being (*b*) in any age ſince the Creation? No, no! but like wiſe and unprejudiced men, let us with David ſay, *Pſal.* cxxxix. 14. (with which I conclude) 'I will praiſe thee, for I am fearfully and wonderfully made; marvellous are thy works, and that my ſoul knoweth right well.'

Having thus made what (conſidering the copiouſneſs and excellence of the ſubject) may be called a very brief ſurvey of man, and ſeen ſuch admirable marks of the divine deſign and art; let us next take a tranſient view of the other inferior creatures, and begin with quadrupeds.

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eorum contemplatione defixus, neſcio quo œſtro admirationis conciter, & quaſi divine furens cohibere me minimè poſſum quin exclamem.

'Magnus Dominus! magnus fabricator hominum Deus! magnus atque admirabilis conditor rerum Deus, quàm magnus es!' Bellin. *de mot. cord. fin.*

(*b*) 'Hoc [*i. e.* mundum effici ornatiſſimum, & pulcherrimum ex concurſione fortuitâ] qui exiſtimat fieri potuiſſe, non intelligo cur non idem putet, ſi innumerabiles unius & viginti formæ literarum, vel aureæ, vel qualeſlibet, aliquo conjiciantur, poſſe ex his in terram excuſſis annales Ennii ut deinceps legi poſſint, effici, &c.---Quod ſi mundum efficere poteſt concurſus atomorum, cur porticum, cur templum, cur domum, cur urbem, non poteſt? Quæ ſunt minus operoſa, & multò quidem faciliora.' Cic. *de nat. deor. l.* 2. *c.* 37.

BOOK VI.

A Survey of QUADRUPEDS.

CHAP. I.

Of their prone Poſture.

IN taking a view of this part of the animal world, ſo far as the ſtructure of their bodies is conformable to that of man, I ſhall paſs them by, and only take notice of ſome peculiarities in them, which are plain indications of deſign, and the divine ſuperintendence and management. And, 1. The moſt viſible apparent variation is the prone poſture of their body: Concerning which, I ſhall take notice only of two things, the parts miniſtring thereto, and the uſe and benefit thereof.

I. As for the parts, it is obſervable, that in all theſe creatures, the legs are made exactly conformable to this poſture, as thoſe in man are to his erect poſture: And what is farther obſervable alſo, is, that the legs and feet are always admirably ſuited to the motion and exerciſes of each animal: In ſome they are made for ſtrength only, to ſupport a vaſt unweildy body (*a*); in others they are made for agility

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(*a*) The Elephant being a creature of prodigious weight, the largeſt of all animals, *Pliny* ſaith, hath its legs accordingly made of an immenſe ſtrength, like pillars, rather than legs.

agility and ſwiftneſs (*b*); in ſome they are made for only walking and running; in others for that, and ſwimming too (*c*); in others for walking and digging (*d*); and in others for walking

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(*b*) Deer, Hares, and other creatures, remarkable for ſwiftneſs, have their legs accordingly ſlender, but withal ſtrong, and every way adapted to their ſwiftneſs.

(*c*) Thus the feet of the Otter are made, the toes being all conjoined with membranes, as the feet of geeſe and ducks are. And in ſwimming, it is obſervable, that when the foot goes forward in the water, the toes are cloſe; but when backward, they are ſpread out, whereby they more forcibly ſtrike the water, and drive themſelves forward. The ſame may be obſerved alſo in ducks and geeſe, &c.

Of the Caſtor or Beaver, the *French* academiſts ſay, 'The ſtructure of the feet was very extraordinary, and ſufficiently demonſtrated, that nature hath deſigned this animal to live in the water, as well as upon land. For although it had four feet, like terreſtrial animals, yet the hindmoſt ſeemed more proper to ſwim, than walk with; the five toes of which they were compoſed, being joined together like thoſe of a gooſe by a membrane, which ſerves this animal to ſwim with. But the fore ones were made otherwiſe; for there was no membrane which held thoſe toes joined together: and this was requiſite, for the conveniency of this animal, which uſeth them as hands like a ſquirrel, when he eats.' *Memoirs for a natural hiſtory of animals, pag.* 84.

(*d*) The Mole's feet are a remarkable inſtance.

walking and flying (*e*): in ſome they are made more laſk and weak, for the plainer lands; in others rigid, ſtiff, and leſs flexible (*f*), for traverſing the ice, and dangerous precipices of the high mountains (*g*); in ſome they are ſhod with rough and hard hoofs, ſome whole, ſome cleft; in others with only a callous ſkin. In which latter, it is obſervable that the feet are

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(*e*) The wings of the Bat are a prodigious deviation from nature's ordinary way. So it is in the *Virginian* ſquirrel, whoſe ſkin is extended between the fore legs and its body.

(*f*) Of the legs of the Elk, the *French* academiſts ſay, 'Although ſome authors report, that 'there are Elks in *Muſcovia*, whoſe legs are jointleſs; there is great probability, that this opinion 'is founded on what is reported of thoſe Elks of '*Muſcovia*, as well as of *Cæſar*'s Alce, and *Pliny*'s 'Machlis, that they have legs ſo ſtiff and inflexible, that they do run on ice without ſlipping; 'which is a way that is reported that they have 'to ſave themſelves from the wolves, &c.' *Ibid. p.* 108.

(*g*) The common tame Goat (whoſe habitation is generally on mountains and rocks, and who delighteth to walk on the tops of pales, houſes, &c. and to take great and ſeemingly dangerous leaps) I have obſerved, hath the joints of the legs very ſtiff and ſtrong, the hoof hollow underneath, and its edges ſharp. The like I doubt not is to be found in the wild Goat, conſidering what Dr. *Scheuchzer* hath ſaid of its climbing the moſt dangerous craggs of the *Alps*, and the manner of their hunting it, *Vid. Iter. Alpin.* 3. *p.* 9.

are compoſed of toes, ſome ſhort for bare going; ſome long to ſupply the place of a hand (*b*); ſome armed with long and ſtrong talons to catch, hold, and tear the prey; ſome fenced only with ſhort nails, to confirm the ſteps in running and walking.

II. As the poſture of man's body is the fitteſt for a rational animal, ſo is the prone poſture of Quadrupeds the moſt uſeful and beneficial to themſelves, as alſo moſt ſerviceable to man. For they are hereby better made for their gathering their food, to purſue their prey, to leap, to climb, to ſwim, to guard themſelves againſt their enemies; and, in a word, to do whatever may be of principal uſe to themſelves; as alſo they are hereby rendered more uſeful and ſerviceable to man, for carrying his burthens, for tilling his ground; yea, even for his ſports and diverſions.

And now I might here add a ſurvey of the excellent contrivance of the parts miniſtring to this poſture of the four-footed animals, the admirable ſtructure of the bones (*i*), the joints and

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(*b*) Thus in Apes and Monkeys, in the Beaver before, and divers others.

(*i*) It is a ſingular proviſion nature hath made for the ſtrength of the Lion, if that be true, which *Galen* ſaith is reported of its bones being not hollow (as in other animals) but ſolid: which report he thus far confirms, that moſt of the bones are ſo; and that thoſe in the legs, and ſome other parts, have only a ſmall and obſcure cavity in them. *Vid.* Galen. *de uſ. part. l.* 11. *c.* 18.

and muſcles, their various ſizes and ſtrength; their commodious lodgment and ſituation, the nice æquipoiſe of the body, with a great deal more to the ſame purpoſe. But I ſhould be tedious to inſiſt minutely upon ſuch particulars; and beſides I have given a touch upon theſe kind of things, when I ſpake of man.

Paſſing by therefore many things of this kind, that might deſerve remark, I ſhall only conſider ſome of the parts of the Quadrupeds, differing from what is found in man (*k*), and which are manifeſt works of deſign.

(*k*) 'Theſe ſorts of differences in the Mechaniſm of animals, upon the ſcore of the poſition of their bodies, occur ſo often, that it would be no mean ſervice to anatomy----if any one would give us a hiſtory of thoſe variations of the parts of animals, which ſpring from the different poſtures of their bodies.' Drake *anat. v.* 1. *b.* 1. *c.* 17.

CHAP. II.

Of the Heads of Quadrupeds.

IT is remarkable that in man, the head is of one ſingular form; in the four-footed race, as various as their ſpecies. In ſome, ſquare and large, ſuitable to their ſlow motion, food, and abode; in others leſs, ſlender and ſharp, agreeable to their food (*a*), or habitation

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(*a*) Thus Swine, for inſtance, who dig in the earth for roots, and other food, have their neck, tion under ground (*b*). But paſſing by a great many obſervations that might be made of this kind, I ſhall ſtop a little at the brain, as the moſt conſiderable part of this part of the body, being the great inſtrument of life and motion in Quadrupeds, as it is in man of that, as alſo in all probability the chief ſeat of his immortal ſoul. And accordingly it is a remarkable difference, that in man the brain is large, affording ſubſtance and room for ſo noble a gueſt; whereas in Quadrupeds, it is but ſmall. And another thing, no leſs remarkable, is the ſituation of the Cerebrum and Cerebellum, or the greater or leſſer brain, which I ſhall give in the words of one of the moſt exact anatomiſts we have of that part (*c*): ‘ Since, ſaith he, God hath given to man a ‘ lofty countenance, to behold the heavens, ‘ and hath alſo ſeated an immortal ſoul in ‘ the

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and all parts of their head very well adapted to that ſervice. Their neck ſhort, brawny, and ſtrong; their eyes ſet pretty high out of the way; their ſnout long; their noſe callous and ſtrong; and their ſenſe of ſmelling very accurate, to hunt out and diſtinguiſh their food in mud, under ground, and other the like places where it lies concealed.

(*b*) What hath been ſaid of Swine is no leſs, rather more remarkable in the Mole, whoſe neck, noſe, eyes and ears, are all fitted in the niceſt manner, to its ſubterraneous way of life.

(*c*) Willis *Cereb. Anat. cap.* 6. ‘ Cumque huic ‘ Deus os ſublime dederit, &c.’

'the brain, capable of the contemplation of 'heavenly things; therefore, as his face is 'erect, ſo the brain is ſet in an higher place, 'namely, above the Cerebellum, and all the 'ſenſories. But in brutes, whoſe face is prone 'towards the earth, and whoſe brain is inca'pable of ſpeculation, the Cerebellum (whoſe 'buſineſs it is to miniſter to the actions and 'functions of the Præcordia, the principal office 'in thoſe creatures) in them is ſituated in the 'higher place, and the Cerebrum lower. 'Alſo ſome of the organs of ſenſe, as the 'ears and eyes, are placed, if not above the 'Cerebrum, yet at leaſt equal thereto.'

Another convenience in this poſition of the Cerebrum and Cerebellum, the laſt ingenious anatomiſt tells us is this. (*d*) 'In the head 'of man, ſaith he, the baſe of the Brain and 'Cerebell, yea, of the whole ſkull, is ſet 'parallel to the horizon; by which means 'there is the leſs danger of the two brains 'joggling, or ſlipping out of their place. 'But in Quadrupeds, whoſe head hangs 'down, the baſe of the ſkull makes a 'right angle with the horizon, by which 'means the brain is undermoſt, and the Ce'rebell uppermoſt; ſo that one would be 'apt to imagine the Cerebell ſhould not be 'ſteady, but joggle out of its place.' To remedy which inconvenience, he tells us, 'And

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(*d*) Id. paulo poſt. 'In capite humano Cere'bri & Cerebelli, &c.'

‘ And leſt the frequent concuſſions of the Ce‘ rebell ſhould cauſe a fainting, or diſorderly ‘ motion of the ſpirits about the Præcordia; ‘ therefore, by the artifice of nature, ſufficient ‘ proviſion is made in all, by the Dura Me‘ ninx cloſly encompaſſing the Cerebellum; ‘ beſides which, it is, in ſome, guarded with ‘ a ſtrong bony fence; and in others, as the ‘ Hare, the Coney, and ſuch leſſer Quadru‘ peds, a part of the Cerebell is on each ſide ‘ fenced with the Os Petroſum: ſo that by ‘ this double ſtay, its whole maſs is firmly ‘ contained within the ſkull.’

Beſides theſe peculiarities, I might take notice of divers other things no leſs remarkable, as the nictitating Membrane of the eye (*e*), the different paſſages of the Carotid arteries (*f*) through the ſkull, their branching into

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(*e*) See *book* iv. *chap*. 2. *note* (*kk*)

(*f*) ‘ Arteria carotis aliquanto poſterius in ho‘ mine quàm in alio quovis animali, calvariam ‘ ingreditur, ſcil. juxta illud foramen, per quod ‘ ſinus lateralis in venam jugularem deſiturus cra‘ nio elabitur; nam in cæteris hæc arteria ſub ex‘ tremitate, ſeu proceſſu acuto oſſis petroſi, inter ‘ cranium emergit: verum in capite humano ea‘ dem, ambage longiori circumducta (ut ſanguinis ‘ torrens, priuſquam ad cerebri oram appellit, ‘ fracto impetu, leniùs & placidiùs fluat) prope ‘ ſpecum ab ingreſſu ſinûs lateralis factum, calva‘ riæ baſin attingit;------& in majorum cautelam, ‘ tunicâ inſuper aſcititiâ craſſiore inveſtitur.’ And ſo he goes on to ſhew the conveniency of this guard into the Rete mirabile (*g*), the different magnitude

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guard the artery hath, and its paſſage to the brain; and then ſaith, ‘ Si hujuſmodi conformationis ratio inquiritur, facilè occurrit, in capite humano, ubi generoſi affectus & magni animorum impetus ac ardores excitantur, ſanguinis in cerebri oras appulſum debere eſſe liberum & expeditum, &c. Atque hoc quidem reſpectu differt homo à pleriſque Brutis, quibus, arteria in mille ſurculos diviſa, ne ſanguinem pleniore alveo, aut citatiore, quàm par eſt, curſu, ad cerebrum evehat, plexus retiformes conſtituit, quibus nempe efficitur, ut ſanguis tardo admodum, lenique & æquabili fere ſtillicidio, in cerebrum illabatur.’ And then he goes on to give a farther account of this artery, and the Rete mirabile, in divers creatures. Willis, *ibid. c.* 8.

(*g*) *Galen* thinks the Rete mirabile is for concocting and elaborating the animal ſpirits, as the Epididymides [the convolutions, κιρσοειδῆς ἕλικος] are for elaborating the ſeed, *de uſ. part. l.* 9. *c.* 4. This Rete is much more conſpicuous in beaſts than man; and, as Dr. *Willis* well judges, ſerves, 1. To bridle the too rapid incurſions of the blood into the brain of thoſe creatures, whoſe heads hang down much. 2. To ſeparate ſome of the ſuperfluous ſerous parts of the blood, and ſend them to the ſalival glands, before the blood enters the brain of thoſe animals, whoſe blood is naturally of a watery conſtitution. 3. To obviate any obſtructions that may happen in the arteries, by giving a free paſſage through other veſſels, when ſome are ſtopped.

In Quadrupeds, as the Carotid arteries are branched into the Rete mirabile, for the bridling the too nitude of the Nates, and ſome other parts of the brain in beaſts, quite different from what it is in man: but the touches already given, may be inſtances ſufficient to prevent my being tedious in enlarging upon theſe admirable works of God.

CHAP. III.

Of the Necks of Quadrupeds.

FROM the head paſs we to the neck, no principal part of the body, but yet a good inſtance of the Creator's wiſdom and deſign, inaſmuch as in man it is ſhort, agreeable to the erection of his body; but in the four-footed tribe it is long, anſwerable to the length of the legs (*a*), and in ſome of theſe

long

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too rapid current of blood into the brain; ſo the Vertebral arteries are, near their entrance into the ſkull, bent into an acuter angle than in man, which is a wiſe proviſion for the ſame purpoſe.

(*a*) It is very remarkable that in all the ſpecies of Quadrupeds, this equality holds, except only the Elephant; and that there ſhould be a ſufficient ſpecial proviſion made for that creature, by its Proboſcis or Trunk. A member ſo admirably contrived, ſo curiouſly wrought, and with ſo great agility and readineſs applied by that unweildy creature to all its ſeveral occaſions, that I take it to be a manifeſt inſtance of the Creator's workmanſhip. See its anatomy in Dr. A. Moulen's *Anat. of the Elephant*, p. 33. As alſo in Mr. *Blair*'s account in *Philoſ. Tranſact.* N°. 326.

‘ Alilong, and leſs ſtrong, ſerving to carry the mouth to the ground; in others ſhorter, brawny, and ſtrong, ſerving to dig and heave up great burdens (*b*).

But that which deſerves ſpecial remark is, that peculiar proviſion made in the necks of all, or moſt granivorous Quadrupeds, for the perpetual holding down their heads in gathering their food, by that ſtrong, tendinous, and inſenſible Aponeuroſis, or ligament (*c*), braced from the head to the middle of the back. By which means the head, although heavy, may be long held down without

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'Aliorum ea eſt humilitas, ut cibum terreſtrem 'roſtris facilè contingant. Quæ autem altiora ſunt, 'ut Anſeres, ut Cygni, ut Grues, ut Cameli, ad'juvantur proceritate collorum. Manus etiam 'data Elephantis, qui propter magnitudinem cor'poris difficiles aditus habebant ad paſtum.' Cic. *de nat. deor. l.* 2. *c.* 47.

'Quod iis animalibus quæ pedes habent fiſſos in 'digitos, collum brevius ſit factum, quàm ut per 'ipſum cibum ori admovere queant: iis verò quæ 'ungulas habent ſolidas, aut biſidas, longius, ut 'prona atque inclinantia paſci queant. Quî id eti'am opus non ſit artificis utilitatis memoris? Ad 'hæc quod Gues ac Ciconiæ, cùm crura haberent 'longiora, ob eam cauſam roſtrum etiam magnum, '& collum longius habuerint. Piſces autem neque 'collum penitus habuere, utpote qui neque crura 'habent. Quo pacto non id etiam eſt admiran'dum?' Galen. *de uſu part. l.* 11. *c.* 8.

(*b*) As in Moles and Swine, in *chap.* 2. *note* (*a*).

(*c*) Called the White-leather, Pack-wax, Tax-wax, and Fix-fax.

out any labour, pain, or uneaſineſs, to the muſcles of the neck, that would otherwiſe be wearied by being ſo long put upon the ſtretch.

CHAP. IV.

Of the Stomachs of Quadrupeds.

FROM the neck, let us deſcend to the Stomach, a part, as of abſolute neceſſity to the being and well-being of animals, ſo is, in the ſeveral ſpecies of Quadrupeds, ſized, contrived, and made with the utmoſt variety and art. (*a*) What artiſt, what being, but the infinite Conſervator of the world, could ſo well adapt every food to all the ſeveral kinds of thoſe grand devourers of it! who could ſo well ſuit their ſtomachs to the reception and digeſtion thereof; one kind of ſtomach

(*a*) The peculiar contrivance and make of the Dromedary's or Camel's ſtomach, is very remarkable, which I will give from the Pariſian Anatomiſts: 'At the top of the ſecond [*of the four* '*ventricles*] there were ſeveral ſquare holes, which 'were the orifices of about 30 cavities, made like 'ſacks placed between the two membranes, which 'do compoſe the ſubſtance of this ventricle. The 'view of theſe ſacks made us to think that they 'might well be the reſervatories, where *Pliny* 'ſaith, that Camels do a long time keep the water, 'which they drink in great abundance------to 'ſupply the wants thereof in the dry deſerts, &c.' Vid. *memoirs, &c. anat. of Dromedary, p.* 39. See alſo *Peyer. Merycol. l.* 2. *c.* 3.

ſtomach to the carnivorous, another to the herbaceous animals; one fitted to digeſt by bare maſtication; and a whole ſet of ſtomachs in others, to digeſt with the help of rumination! which laſt act, together with the apparatus for that ſervice; is ſo peculiar, and withal ſo curious an artifice of nature, that it might juſtly deſerve a more particular enquiry; but having formerly mentioned it (*b*), and leſt I ſhould be too tedious, I ſhall paſs it by.

(*b*) *Book* iv. *chap.* 11.

CHAP. V.

Of the Hearts of Quadrupeds.

IN this part there is a notable difference found between the heart of man and that of beaſts; concerning the latter of which I might take notice of the remarkable conformation of the hearts of amphibious Quadrupeds, and their difference from thoſe of land-animals, ſome having but one ventricle (*a*), ſome three (*b*), and ſome but two (like land-animals)

(*a*) Frogs are generally thought to have but one ventricle in their hearts.

(*b*) The Tortoiſe has three ventricles, as the Pariſian Academiſts in their memoirs affirm. ‘ Beſides theſe two ventricles [before ſpoken of] ‘ which were in the hinder part of the heart, which ‘ faceth the ſpine, there was, ſay they, a third in ‘ the animals) but then the Foramen Ovale therewith (*c*). All which may be juſtly eſteemed as wonderful, as they are excellent proviſions for the manner of thoſe animals living. But I ſhall content myſelf with bare hints of theſe things, and ſpeak only of two peculiars more, and that but briefly.

One is, the ſituation of the heart, which in beaſts is near the middle of the whole body, in man, nearer the head (*d*). The reaſons of which I ſhall give from one of the moſt curious

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'the fore-part, inclining a little towards the right 'ſide, &c.' *Memoirs, &c. p.* 259. But Mr. *Buſſiere* charges this as a miſtake in thoſe ingenious gentlemen, and aſſerts there is but one ventricle in the Tortoiſe's heart. See his deſcription of the heart of the Land-Tortoiſe, in *Philoſ. Tranſact.* Nº. 328.

(*c*) The Sea-Calf is ſaid by the French Academiſts, to have this proviſion, and their account of it is this: 'Its heart was round and flat, its ventricles appeared very large, and its auricles ſmall. '---Underneath the great aperture, through which 'the trunk of the Vena Cava conveyed the blood 'into the right ventricle of the heart, there was 'another, which penetrated into the Arteria Venoſa, and from thence into the left ventricle, 'and afterwards into the Aorta. This hole, called 'the Foramen Ovale in the Fœtus, makes the 'Anaſtomoſis; by the means of which, the blood 'goes from the Cava into the Aorta, without 'paſſing through the lungs.' *French Anatomiſts, p.* 124.

(*d*) Τὴν τε Καρδίαν περὶ τὸ μέσον πλὴν ἐν Ἀνθρώπῳ, &c. Ariſt. *Hiſt. An. l.* 2. *c.* 17.

ous anatomiſts of that part (*e*). ‘ Seeing, ‘ ſaith he, the trajection and diſtribution of ‘ the blood depends wholly on the ſyſtole of ‘ heart, and that its liquor is not driven of ‘ its own nature ſo readily into the upper ‘ parts as into veſſels even with it, or down‑ ‘ wards into thoſe under it: if the ſituation ‘ of the heart had been farther from the ‘ head, it muſt needs either have been made ‘ ſtronger, to caſt out its liquor with greater ‘ force; or elſe the head would want its due ‘ proportion of blood. But in animals that ‘ have a longer neck, and which is extended ‘ towards their food as it were, the heart is ‘ ſeated as far from the other parts; and they ‘ find no inconvenience from it, becauſe they ‘ feed with their head for the moſt part hang‑ ‘ ing down; and ſo the blood, as it hath ‘ farther to go to their head than in others, ‘ ſo it goes a plainer, and often a ſteep ‘ way (*f*).’

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(*e*) Dr. Lower, *de Corde*, *c.* 1.

(*f*) I might have mentioned another wiſe proviſion from the ſame author, which take in his own words: ‘ In vitulis & equis, imò pleriſque ‘ aliis animalibus majoribus, non ſolas propagines ‘ à nervo ſexti paris ut in homine, ſed etiam plu‑ ‘ rimas à nervo intercoſtali, ubi rectà cor tranſit, ‘ cor accedere, imò in parenchyma ejus dimitti: ‘ & hoc ideo à naturâ quaſi ſubſidium brutis com‑ ‘ paratum, ne capita quæ terram prona ſpectant, ‘ non ſatis faciiè aut copioſè ſpiritus animales im‑ ‘ pertirent.’ Blaſii *Anat. Animal. par.* 1. *c.* 4. ex Lowero, *de corde.*

The other peculiar matter is, the faſtening (I formerly mentioned) which the cone of the pericardium hath in man to the diaphragm (*g*), whereas in all Quadrupeds it is looſe. By which means the motion of the midriff, in that neceſſary act of reſpiration, is aſſiſted both in the upright poſture of man, as alſo in the prone poſture of Quadrupeds (*h*), which would be hinder'd, or render'd more difficult, if the caſe was otherwiſe: 'Which muſt needs be 'the effect of wiſdom and deſign, and that

man

(*g*) 'Diaphragmatis circulo nerveo firmiter adhæret [pericardium] quod homini ſingulare; 'nam ab eo in canibus & ſimiis diſtat, item in 'aliis animalibus omnibus.' Bartholin. *anat. l.* 2. *c.* 5.

(*h*) 'Finalem cauſam quod attinet,------cùm 'erectus ſit hominis inceſſus atque figura, eoque 'faciliùs abdominis viſcera ſuo pondere deſcendant, 'minore diaphragmatis nixu atque ſyſtole ad inſpirationem opus eſt: porrò, cùm in exſpiratione 'pariter neceſſarium ſit diaphragma relaxari------ 'cùm capſula cordis omnino connectendum fuit, in 'homine, ne fortè, quamdiu erectus incedit, ab 'hepatis, aliorumque viſcerum appenſorum pondere deorſum adeò deprimeretur, ut neque pulmo 'ſatis concidere, neque expiratio debitò modo peragi potuerit. Quocirca in quadrupedibus, ubi abdominis viſcera in ipſum diaphragma incumbunt, 'ipſumque in pectoris cavitatem ſuo pondere impellunt, iſta partium accretio exſpirationi quidem inutilis, inſpirationi autem debitam diaphragmatis 'tenſionem impediendo, prorſus incommoda fuiſſet.' Lower, *ibid. p.* 8.

'man was intended by nature to walk erect, 'and not upon all-four, as quadrupeds do.' To expreſs it in the words of a great judge in ſuch matters (*i*).

(*i*) Dr. *Tyſon*'s Anatomy of the Orang-Outang, in *Ray*'s Wiſdom of God, *p.* 262.

CHAP. VI.

Of the Difference between Man *and* Quadrupeds *in the nervous Kind.*

THERE is only one difference more between Man and Quadrupeds that I ſhall take notice of, and that is the nervous kind: and becauſe it would be tedious to inſiſt upon many particulars (*a*), I ſhall, for a ſample, inſiſt chiefly upon one, and that is, of nature's prodigious care for a due communication and correſpondence between the head and heart of man, more than what is in the four-footed tribe. For this purpoſe, beſides the correſpondence thoſe parts have by means of

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(*a*) Amongſt theſe, I might name the ſite of the nerves proceeding from the Medulla Spinalis, which Dr. *Lower* takes notice of. In beaſts, whoſe ſpine is above the reſt of the body, the nerves tend directly downwards; but in man, it being erect, the nerves ſpring out of the ſpine, not at right, but in oblique angles downwards, and paſs alſo in the body the ſame way. *Ibid. p.* 16.

of the nerves of the Par Vagum (common both to man and beaſt) there is a farther and more ſpecial communication and correſpondence occaſioned by the branches (*b*) of the Intercoſtal Pair, ſent from the Cervical Plexus to the heart, and Præcordia. By which means the heart and brain of man have a mutual and very intimate correſpondence and concern with each other, more than is in other creatures; or, as one of the moſt curious anatomiſts and obſervers of theſe things ſaith (*c*): ‘Brutes are, as it were, machines made with ‘a ſimpler and leſs operoſe apparatus, and ‘endowed therefore with only one and the ‘ſame kind of motion, are determined to do ‘the ſame thing: whereas in man, there is a ‘great variety of motions and actions. For ‘by the commerce of the aforeſaid Cervical ‘Plexus (*d*) he ſaith, The conceptions of the ‘brain

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(*b*) ‘In pleriſque brutis tantum hâc viâ (*i. e.* ‘by the Par Vagum) & vix omnino per ullos paris ‘intercoſtalis nervos, aditus ad cor aut appendi‘cem ejus pateſcit. Verùm in homine, nervus in‘tercoſtalis, præter officia ejus in imo ventre huic ‘cum cæteris animalibus communia, etiam ante ‘pectoris clauſtra internuncii ſpecialis loco eſt, qui ‘cerebri & cordis ſenſa mutua ultra citraque refert.’ Willis *nervor. deſcr. & uſus, c.* 26.

(*c*) *Idem ibid.* ‘Dum hunc utriuſque ſpeciei dif‘ferentiam perpendo, ſuccurrit animo, bruto eſſe ‘velut machinas, &c.

(*d*) That our great man was not miſtaken, there is great reaſon to imagine, from what he obſerved in diſſecting a Fool. Beſides, the brain being but ſmall, 'brain preſently affect the heart, and agitate 'its veſſels, and whole appendage, together 'with the Diaphragm. From whence the alteration in the motion of the blood, the 'pulſe, and reſpiration. So alſo, on the 'contrary, when any thing affects or alters 'the heart, thoſe impreſſions are not only retorted to the brain by the ſame duct of the 'nerves, but alſo the blood itſelf (its courſe 'being once changed) flies to the brain with a 'different and unuſual courſe, and there agitating the animal ſpirits with divers impulſes, 'produceth various conceptions and thoughts 'in the mind.' And he tells us, 'That 'hence it was that the ancient divines and 'philoſophers too, made the heart the ſeat of 'wiſdom; and, certainly, ſays he, the works 'of wiſdom and virtue do very much depend 'upon this commerce which is between the 'heart and brain:' And ſo he goeth on with more to the ſame purpoſe. Upon the account of this Intercoſtal commerce with the heart being wanting in brutes, there is another ſingularly careful and wiſe proviſion the infinite Creator hath made in them, and that

ſmall, he ſaith, 'Præcipua autem diſcriminis nota 'quam inter illius & viri cordati partes advertimus, 'hæcce erat; nempe quod prædictus nervi intercoſtalis plexus, quem cerebri & cordis internuncium & hominis proprium diximus, in ſtulto hoc 'valde exilis, & minori nervorum ſatellitio ſtipatus 'fuerit.' *Ibid.*

that is, that by reaſon both the Par Vagum, and the Intercoſtal too, do not ſend their branches to the heart, and its appendage in brutes; therefore, leſt their heart ſhould want a due proportion of nervous veſſels, the Par Vagum ſends more branches to their heart than to that of man. This, as it is a remarkable difference between rational and irrational creatures; ſo it is as remarkable an argument of the Creator's art and care; who although he hath denied brute animals reaſon, and the nerves miniſtring thereto, yet hath another way ſupplied what is neceſſary to their life and ſtate. But let us hear the ſame great author's deſcant upon the point (*e*); 'Inaſmuch, ſaith 'he, as beaſts are void of diſcretion, and but 'little ſubject to various and different paſ'ſions, therefore there was no need that the 'ſpirits, that were to be conveyed from the 'brain to the Præcordia, ſhould paſs two dif'ferent ways, namely, one for the ſervice of 'the vital functions, and another for the re'ciprocal impreſſions of the affections; but it 'was ſufficient that all their ſpirits, whatever 'uſe they were deſigned for, ſhould be con'veyed one and the ſame way.'

Here now in the nervous kind we have manifeſt acts of the Creator's deſign and wiſdom, in this ſo manifeſt and diſtinct a proviſion

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(*e*) *Idem ibid. cap.* 29. 'In quantum beſtiæ 'prudentiâ carent, & variis diverſiſque paſſioni'bus, &c.

ſion for rational and irrational creatures; and that man was evidently intended to be the one, as the genus of Quadrupeds was the other.

CHAP. VII.

The CONCLUSION.

AND now it is time to pauſe a while, and reflect upon the whole. And as from the conſiderations in the preceding Book, we have eſpecial reaſon to be thankful to our infinitely merciful Maker, for his no leſs kind, than wonderful contrivances of our body; ſo we have reaſon, from this brief view I have taken of this laſt tribe of the creation, to acknowledge and admire the ſame Creator's work and contrivances in them. For we have here a large family of animals, in every particular reſpect, curiouſly contrived and made, for that eſpecial poſture, place, food, and office or buſineſs which they obtain in the world. So that if we conſider their own particular happineſs and good, or man's uſe and ſervice; or if we view them throughout, and conſider the parts wherein they agree with man, or thoſe eſpecially wherein they differ; we ſhall find all to be ſo far from being things fortuitous, undeſigned, or any way accidental, that every thing is done for the beſt; all wiſely contrived, and incomparably fitted up, and every way worthy of the great Creator. And he he that will ſhut his eyes, and not ſee God (a) in theſe his works, even of the poor beaſts of the earth, that will not ſay (as *Elihu* hath it, *Job* xxxv. 10, 11.) ‘Where is God my maker, who teacheth us more than the beaſts of the earth, and maketh us wiſer than the fowls of the heaven?’ Of ſuch an one we may uſe the pſalmiſt's expreſſion, *Pſalm* xlix. 12. that ‘He is like the beaſts (b) that periſh.’

(a) *----Deum namque ire per omnes*
Terraſque tractuſque maris, cœlumque profundum.
Hinc pecudes, armenta, viros, genus omne ferarum.
Virgil. Georg. *l.* 4.

(b) ‘Illos qui nullum omnino Deum eſſe dixerunt, non modo non philoſophos, ſed ne homines quidem fuiſſe dixerim; qui, mutis ſimillimi, ex ſolo corpore conſtiterunt, nihil videntes animo.’ Lactant. *l.* 7. *c.* 9.

BOOK VII.

A Survey of BIRDS.

HAVING briefly, as well as I could, diſpatched the tribe of quadrupeds; I ſhall next take a brief and tranſient view of the feathered tribe.

And here we have another large province to expatiate in, if we ſhould deſcend to every thing wherein the workmanſhip of the Almighty appears. But I muſt contract my ſurvey

ſurvey as much as may be; and ſhall therefore give only ſuch hints and touches upon this curious family of animals, as may ſerve for ſamples of the reſt of what might be obſerved.

CHAP. I.

Of the Motion of Birds, and the Parts miniſtring thereto.

AS this tribe hath a different motion from that of other animals, and an amphibious way of life; partly in the air, and partly on the land and waters; ſo is their body accordingly ſhaped, and all their parts incomparably fitted for that way of life and motion; as will be found by a curſory view of ſome of the particulars. And the

I. And moſt viſible thing, is the ſhape and make of their body, not thick and clumſy, but incomparably adapted to their flight: ſharp before, to pierce and make way through the air, and then by gentle degrees riſing to its full bulk. To which we may add,

II. The neat poſition of the feathers throughout the body; not ruffled, or diſcompoſed, or placed ſome this, ſome a contrary way, according to the method of chance; but all artificially placed (*a*) for facilitating the motion of the body, and its ſecurity at the ſame time, by way of cloathing: and for that end,

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(*a*) See before, *book* iv. *chap.* 12. *note* (*l*).

end, moſt of the feathers tend backward, and are laid over one another in exact and regular method, armed with warm and ſoft down next the body, and more ſtrongly made, and curiouſly clos'd next the air and weather, to fence off the injuries thereof. To which purpoſe, as alſo for the more eaſy and nimble gliding of the body through the air, the proviſion nature hath made, and the inſtinct of theſe animals to preen and dreſs their feathers, is admirable; both in reſpect of their art and curioſity in doing it, and the oil-bag (*b*), glands, and whole apparatus for that ſervice.

III. And now having ſaid thus much relating to the body's motion, let us ſurvey the grand inſtrument thereof, the wings: which, as they are principal parts, ſo are made with great ſkill, and placed in the moſt commodi-

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(*b*) Mr. *Willoughby* ſaith, there are two glands for the ſecretion of the unctuous matter in the oil-bag. And ſo they appear to be in geeſe. But upon examination, I find, that in moſt other birds (ſuch at leaſt as I have enquired into) there is only one gland; in which are divers little cells, ending in two or three larger cells, lying under the nipple of the oil-bag. This nipple is perforated, and being preſſed, or drawn by the bird's bill, or head, emits the liquid oil, as it is in ſome birds, or thicker unctuous greaſe, as it is in others. The whole oil-bag is in its ſtructure ſomewhat conformable to the breaſts of ſuch animals as afford milk.

ous point of the body (*c*), to give it an exact æquipoiſe in that ſubtle medium the air.

And here it is obſervable, with what incomparable curioſity every feather is made; the ſhaft exceeding ſtrong, but hollow below, for ſtrength and lightneſs ſake; and above, not much leſs ſtrong, and fill'd with a parenchyma or pith, both ſtrong and light too. The vanes as nicely gaug'd on each ſide as made; broad on one ſide, and narrower on the other; both which incomparably miniſter to the progreſſive motion of the bird, as alſo to the union and cloſeneſs of the wing (*d*).

And

(*c*) In all birds that fly much, or that have the moſt occaſion for their wings, it is manifeſt that their wings are placed in the very beſt part, to balance their body in the air, and to give as ſwift a progreſſion, as their wings and body are capable of: for otherwiſe we ſhould perceive them to reel, and fly unſteadily; as we ſee them to do, if we alter their æquipoiſe, by cutting the end of one of the wings, or hanging a weight at any of the extreme parts of the body. But as for ſuch birds as have as much occaſion for ſwimming as flying, and whoſe wings are therefore ſet a little out of the centre of the body's gravity, ſee *book* iv. *chap.* 8. *note* (*q*), and for ſuch as have more occaſion for diving than flying, and whoſe legs are, for that reaſon, ſet more backward, and their wings more forward, ſee *chap.* 4. *note* (*k*), of this book.

(*d*) The wiſe author of nature hath afforded an example of the great nicety in the formation of

birds,

And no leſs inquiſitive is the textrine art of the plumage (*e*) alſo; which is ſo curiouſly wrought,

birds, by the nicety obſerv'd in a part no more conſiderable than the vanes of the flag-feathers of the wing. Among others, theſe two things are obſervable: 1. The edges of the exterior or narrow vanes bend downwards, but of the interior wider vanes upwards; by which means they catch, hold, and lie cloſe to one another, when the wing is ſpread; ſo that not one feather may miſs its full force and impulſe upon the air. 2. A yet leſſer nicety is obſerved, and that is, in the very ſloping the tips of the flag-feathers: the interior vanes being neatly ſloped away to a point, towards the outward part of the wing; and the exterior vanes ſloped towards the body, at leaſt in many birds; and in the middle of the wing, the vanes being equal, are but little ſloped. So that the wing, whether extended or ſhut, is as neatly ſloped and formed, as if conſtantly trimmed with a pair of ſciſſors.

(*e*) Since no exact account, that I know of, hath been given of the mechaniſm of the vanes or webs of the feathers, my obſervation may not be unacceptable. The vane conſiſts not of one continued membrane; becauſe if once broken, it would hardly be reparable: but of many Laminæ, which are thin, ſtiff, and ſomewhat of the nature of a thin quill. Towards the ſhaft of the feather (eſpecially in the flag-feathers of the wing) thoſe Laminæ are broad, &c. of a ſemicircular form; which ſerve for ſtrength, and for the cloſer ſhutting of the Laminæ to one another, when impulſes are made upon the air. Towards the outward part of the vane, theſe Laminæ grow ſlender and taper: On their wrought, and ſo artificially interwoven, that it cannot be viewed without admiration, eſpecially when the eye is aſſiſted with glaſſes.

And as curiouſly made, ſo no leſs curiouſly are the feathers placed in the wing, exactly according to their ſeveral lengths and ſtrength: the principals ſet for ſtay and ſtrength, and theſe again well lined, faced, and guarded with the covers and ſecondary feathers, to keep the air from paſſing through, whereby the ſtronger impulſes are made thereupon.

And

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their under ſide they are thin and ſmooth, but their upper outer edge is parted into two hairy edges, each ſide having a different ſort of hairs, laminated or broad at bottom, and ſlender and bearded above the other half. I have, as well as I could, repreſented the uppermoſt edge of one of theſe Laminæ in *fig.* 18. with ſome of the hairs on each ſide, magnify'd with a microſcope. Theſe bearded briſtles, or hairs, on one ſide the Laminæ, have ſtrait beards, as in *fig.* 19. thoſe on the other ſide have hook'd beards on one ſide the ſlender part of the briſtle, and ſtrait ones on the other, as in *fig.* 20. Both theſe ſorts of briſtles magnify'd (only ſcattering, and not cloſe) are repreſented as they grow upon the upper edge of the Lamina *ſ. t.* in *fig.* 18. And in the vane, the hook'd beards of one Lamina always lie next the ſtrait beards of the next Lamina; and by that means lock and hold each other; and by a pretty mechaniſm, brace the Laminæ cloſe to one another. And if at any time the vane happens to be ruffled and diſcompoſed, it can by this pretty eaſy mechaniſm be reduced and repaired. *Vid. book* v. *chap.* 12. *note* (*m*).

And laſtly, to ſay no more of this part, that deſerves more to be ſaid of it, what an admirable apparatus is there of bones, very ſtrong, but withal light, and incomparably wrought? Of joints, which open, ſhut, and every way move, according to the occaſions either of extending it in flight, or withdrawing the wing again to the body? and of various muſcles; among which the peculiar ſtrength of the pectoral muſcles deſerves eſpecial remark, by reaſon they are much ſtronger (*f*) in birds than in man, or any other animal, not made for flying.

IV. Next the wings, the tail is in flight conſiderable; greatly aſſiſting in all aſcents and

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(*f*) ‘ Pectorales muſculi hominis flectentes humeros, parvi & parum carnoſi ſunt; non æquant 50am aut 70am partem omnium muſculorum hominis. E contra in avibus, pectorales muſculi vaſtiſſimi ſunt, & æquant, imò excedunt, & magis pendent, quam reliqui omnes muſculi ejuſdem avis ſimul ſumpti.’ Borell. *de mot. animal. vol.* I. *prop.* 184.

Mr. *Willughby* having made the like obſervation, hath this reflection on it, ‘ Whence, if it be poſſible for man to fly, it is thought by them who have curiouſly weighed and conſidered the matter, that he that would attempt ſuch a thing with hopes of ſucceſs, muſt ſo contrive and adapt his wings, that he may make uſe of his legs, and not his arms, in managing them,’ (becauſe the muſcles of the legs are ſtronger, as he obſerves). Willugh. *Ornith. l.* 1. *c.* 1. §. 19.

and deſcents in the air, and alſo ſerving to ſteady (g) flight, by keeping the body upright in that ſubtle and yielding medium, by its readily turning and anſwering every vacillation of the body.

And now to the parts ſerving to flight, let us add the nice and complete manner of its performance; all done according to the ſtricteſt rules of mechaniſm (*b*). What rower on the waters, what artiſt on the land, what acuteſt mathematician could give a more agreeable and exact motion to the wings, than theſe untaught flying artiſts do to theirs! ſerving not only to bear their bodies up in the air, but alſo to waſt them along therein, with a ſpeedy progreſſive motion; as alſo to ſteer and turn them this way and that way, up and down, faſter and ſlower, as their occaſions require, or their pleaſure leads them.

V. Next to the parts for flight, let us view the feet and legs miniſtring to their other motion:

(g) Mr. *Willughby*, *Ray*, and many others, imagine the principal uſe of the tail to be to ſteer and turn the body in the air, as a rudder. But *Borelli* hath put it beyond all doubt that this is the leaſt uſe of it, and that it is chiefly to aſſiſt the bird in its aſcents and deſcents in the air, and to obviate the vacillations of the body and wings. For as for turning to this or that ſide, it is performed by the wings and inclination of the body, and but very little by the help of the tail.

(*b*) See Borelli, *ubi ſupra*, *prop*. 182. *&c.*

motion: both made light, for eaſier tranſportation through the air; and the former ſpread, ſome with membranes for ſwimming (*i*), ſome without, for ſteady going, for perching, for catching and holding of prey (*k*), or for hanging by the heels to gather their food (*l*), or to fix themſelves in their place of

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(*i*) It is conſiderable in all water-fowl, how exactly their legs and feet correſpond to that way of life. For either their legs are long, to enable them to wade in the waters: in which caſe, their legs are bare of feathers a good way above the knees, the more conveniently for this purpoſe. Their toes alſo are all broad; and in ſuch as bear the name of Mud-ſuckers, two of the toes are ſomewhat joined, that they may not eaſily ſink in walking upon boggy places. And as for ſuch as are whole-footed, or whoſe toes are webbed together (excepting ſome few) their legs are generally ſhort, which is the moſt convenient ſize for ſwimming. And 'tis pretty enough to ſee how artificially they gather up their toes and feet when they withdraw their legs, or go to take their ſtroke; and as artificially again extend or open their whole foot, when they preſs upon, or drive themſelves forward in the waters.

(*k*) Some of the characteriſticks of rapacious birds are 'to have hooked, ſtrong, and ſharp-pointed 'beaks and talons, fitted for rapine, and tearing 'of fleſh; and ſtrong and brawny thighs, for ſtrik'ing down their prey.' Willughby *Ornith. l.* 2. *c.* 1. Raii *Synopſ. Av. method. p.* 1.

(*l*) Such birds as climb, particularly thoſe of the Woodpecker-kind, have for this purpoſe (as Mr. *Willughby* obſerves, *l.* 2. *c.* 4.) 1. Strong and muſculous of retreat and ſafety. And the latter, namely, the legs, all curved for their eaſy perching, rooſting, and reſt; as alſo to help them upon their wings in taking their flight, and to be therein commodiouſly tucked up to the body, ſo as not to obſtruct their flight. In ſome long, for wading and ſearching the waters; in ſome of a moderate length, anſwerable to their vulgar occaſions; and in others as remarkably ſhort, to anſwer their eſpecial occaſions and manner of life (*m*). To all theſe

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culous thighs. 2. Short legs and very ſtrong. 3. Toes ſtanding two forwards and two backwards. Their toes alſo are cloſe joined together, that they may more ſtrongly and firmly lay hold on the tree they climb upon. 4. All of them----have a hard ſtiff tail, bending alſo downwards, on which they lean, and ſo bear up themſelves in climbing.

(*m*) Swifts and Swallows have remarkably ſhort legs, eſpecially the former, and their toes graſp any thing very ſtrongly. All which is uſeful to them in building their neſts, and other ſuch occaſions as neceſſitate them to hang frequently by their heels. But there is far greater uſe of this ſtructure of their legs and feet, if the reports be true of their hanging by the heels in great cluſters (after the manner of bees) in mines and grottos, and on the rocks by the ſea, all the winter. Of which latter, I remember the late learned Dr. *Fry* told this ſtory at the univerſity, and confirmed it to me ſince; viz. That an ancient fiſherman, accounted an honeſt man, being near ſome rocks on the coaſt of *Cornwall*, ſaw, at a very low ebb, a black liſt of ſomething adhering to theſe let us add the placing theſe laſt mentioned parts of the body. In all ſomewhat out of the center of the body's gravity (*n*), but in ſuch as ſwim, more than in others, for the better rowing their bodies through the waters, or to help them in their diving (*o*) too.

to the rock, which when he came to examine, he found it was a great number of Swallows, and, if I miſremember not, of Swifts alſo, hanging by the feet to one another, as bees do; which were covered commonly by the ſea-waters, but revived in his warm hand, and by the fire. All this the fiſherman himſelf aſſured the doctor of. Of this, ſee more, *chap.* 3. *note* (*d*) of this book.

(*n*) In birds that frequent not the waters, the wings are in the center of gravity, when the bird lies along, as in flying; but when it ſtands or walks, the erection of the body throws the center of gravity upon the thighs and feet.

(*o*) See *chap.* 4. *note* (*k*).

CHAP. II.

Of the Head, Stomach, and other parts of Birds.

THUS having diſpatched the parts principally concerned in the motion of the feathered tribe, let us proceed to ſome other parts not yet animadverted upon. And we will begin with the head, concerning which I have already taken notice of its ſhape for making way through the air; of the make of of the bill, for gathering food, and other uſes; the commodious ſituation of the eye; and I might add that of the ear too, which would be in the way, and obſtruct flight, if it was like that of moſt other animals: alſo I might ſay a great deal of the conformation of the brain, and of the parts therein wanting, and of others added, like to what is obſervable in fiſhes; whoſe poſture in the waters reſembles that of birds in the air (*a*), and both very different from man and beaſts; and laſtly, to hint at no more, I might ſurvey the peculiar ſtructure of the Larynx (*b*), the

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(*a*) ‘Cerebra hominum & quadrupedum in pleriſque ſimilia exiſtunt.------Capitibus volucrum & piſcium contenta, ab utriſque prioribus longè diverſa, tamen inter ſe, quoad præcipuas ἐγκεφάλου partes, ſymbola reperiuntur.’ The particulars wherein the brains of birds and fiſhes agree with one another, and wherein they differ from the brain of man and beaſts, ſee in the ſame juſtly famous author, Willis *Cereb. anat. c.* 5.

(*b*) ‘Circa bifurcationem aſperæ arteriæ, elegans artificis liberè agentis indicium detegitur ex avium comparatione cum quadrupedibus: cùm vocis gratia in diverſis avibus diverſam muſculorum fabricam bifurcationi aſperæ arteriæ dederit, quorum nullum veſtigium extat in homine & quadrupedibus mihi viſis, ubi omnes vocis muſculos capiti arteriæ junxit. In aquilâ, &c. ſupra bifurcationem, &c.’ Steno *in Blaſ. anat. animal. p.* 2. *c.* 4.

The Aſpera Arteria is very remarkable in the Swan, which is thus deſcribed by *T. Bartholin*; viz. ‘Aſpera the tongue (*c*), the inner ear (*d*), and many

matters

‘ Aſpera arteria admirandæ ſatis ſtructuræ. Nam
‘ pro colli longitudine deorſum Oeſophagi comes
‘ protenditur donec ad ſternum perveniat, in cujus
‘ capſulam ſe incurvo flexu inſinuat & recondit,
‘ velut in tuto loco & thecâ, moxque ad fundum
‘ ejuſdem cavitatis delata ſurſum reflectitur, egrediturque
‘ anguſtias ſterni, & claviculis mediis conſcenſis,
‘ quibus ut fulcro nititur, ad thoracem
‘ ſe flectit------- Miranda hercle modis omnibus
‘ conſtitutio & reſpirationi inſervit & voci. Nam
‘ cùm in ſtagnorum fundo edulia pro victu quærat,
‘ longiſſimo indiguit collo, ne longa mora ſuffocationis
‘ incurreret periculum. Et certè dum dimidiam
‘ fere horam toto capite & collo pronis vado
‘ immergitur, pedibus in altum elatis cœloque obverſis,
‘ ex eâ arteriæ quæ pectoris dictæ vaginæ
‘ recluſa eſt portione, tanquam ex condo promo
‘ ſpiritum haurit.’ Blas. *ibid.* c. 10.

(*c*) The ſtructure of the tongue of the Woodpecker is very ſingular and remarkable, whether we look at its great length, its bones and muſcles, its encompaſſing part of the neck and head, the better to exert itſelf in length; and again, to retract it into its cell; and laſtly, whether we look at its ſharp, horny, bearded point, and the gluey matter at the end of it, the better to ſtab, to ſtick unto, and draw out little maggots out of wood. ’Utilis enim
‘ picis (ſaith *Coiter*) ad vermiculos, formicas, aliaque
‘ inſecta venanda talis lingua foret. Siquidem picus,
‘ innata ſuâ ſagacitate cùm deprehendit alibi
‘ in arboribus, vel carie, vel aliâ de causâ cavatis,
‘ vermes inſectaque deliteſcere, ad illas volitat, ſeſeque
‘ digitis, unguliſque poſterioribus robuſtiſſimis,
‘ & caudæ pennis rigidiſſimis ſuſtentat, donec

‘ valido

‘ valido ac peracuto roſtro arborem pertundat: arbore pertuſâ, foramini roſtrum immittit, ac quo animalcula ſtridore excitet percellatque, magnam in arboris cavo emittit vocem, inſecta vociferatione hâc concitata huc illucque repunt; picus vero linguam ſuam exerit, atque aculeis, hamiſque animalia infigit, infixa attrahit & devorat.’ *Vide* Blaſii *ubi ſupra, p.* 2, *c.* 24.

(*d*) I have before in *book* iv. *chap.* 3. *note* (*u*), taken notice of what others have obſerved concerning the inner ear of birds, reſerving my own obſervations for this place; which I hope may be acceptable, not only for being ſome of them new, but alſo ſhewing the mechaniſm of hearing in general.

In this organ of birds, I ſhall take notice only of three parts, the Membranes and Cartilages; the Columella; and the Conclave: The Drum, as ſome call it, or Membrana Tympani, as others, conſiſts of two membranes, the outer, which covers the whole Meatus, Baſon, or Drum (as ſome call it) and the inner membrane. To ſupport, diſtend, and relax the outermoſt, there is one ſingle cartilage, reaching from the ſide of the Meatus, to near the middle of the membrane. On the top of the Columella is another cartilage, conſiſting of three branches, *a*, *b*, *c*, in *fig.* 23. The longeſt middle branch *a*, is joined to the top of the ſingle upper cartilage before ſpoken of, and aſſiſts it to bear up the upper outer membrane: The two branches, *b*, *c*, are joined to the Os Petroſum, at ſome diſtance from the outer membrane: Upon this inner cartilage, is the inner membrane fixed, the two outer ſides of which, *a*, *b*, and *a*, *c*, are joined to the outer membrane, and make a kind of a three-ſquare bag. The deſign of the two branches or legs of the cartilage, *b*, *c*, are, I conceive, to keep the cartilage and Columella from wavering ſide-ways, and to hinder them from flying too much back: There is a very fine ſlender ligament extended from the oppoſite ſide, quite croſs the Meatus, or baſon, to the bottom of the cartilage, near its joining to the Columella. Thus much for the Membranæ Tympani, and their cartilages.

The next part is the Columella (as *Schelhammer* calls it.) This is a very fine, thin, light, bony tube; the bottom of which ſpreads about, and gives it the reſemblance of a wooden pot-lid, ſuch as I have ſeen in the country-houſes. It exactly ſhuts into, and covers a Foramen of the Conclave, to which it is braced all round, with a fine ſubtile membrane, compoſed of the tender auditory nerve. This bottom or baſe of the Columella, I call the Operculum.

The laſt part, which ſome call the Labyrinth and Cochlea, conſiſting of branches more like the Canales Semicirculares in man, than the Cochlea, I call the Conclave Auditûs. It is (as in moſt other animals) made of hard context bone. In moſt of the birds I have opened, there are circular canals, ſome larger, ſome leſſer, croſſing one another at right angles, which open into the conclave. But in the gooſe it is otherwiſe, there being cochleous canals, but not like thoſe of other birds. In the Conclave, at the ſide oppoſite to the Operculum, the tender part of the auditory nerve enters, and lineth all thoſe, inner retired parts; viz. the Conclave and Canals.

As to the paſſages, Columnæ, and other parts obſervable in the ear of birds, I ſhall paſs them by, it being ſufficient to my purpoſe, to have deſcribed the parts principally concerned in the act of hearing. And as the ear is in birds the moſt ſimple and in-

complex

matters beſides; but for a ſample, I ſhall only inſiſt upon the wonderful proviſion in the bill for

complex of any animal's ear; ſo we may from it make an eaſy and rational judgment how hearing is performed; viz. Sound being a tremor or undulation in the air, cauſed by the colliſion of bodies, doth, as it moves along, ſtrike upon the Drum, or Membrana Tympani, of the ear: which motion, whether ſtrong or languid, ſhrill or ſoft, tuneful or not, is at the ſame inſtant impreſſed upon the Cartilages, Columella, and Operculum, and ſo communicated to the auditory Nerve in the Conclave.

And now if we compare the organ and act of hearing with thoſe of ſight, we ſhall find that the Conclave is to hearing, as the Retina is to ſight; that ſonorous bodies make their impreſſions thereby on the brain, as viſible objects do by the Retina. Alſo, that as there is an apparatus in the eye, by the opening and ſhutting of the pupil, to make it correſpond to all the degrees of light, ſo there is in the ear, to make it conformable to all the degrees of ſound, a noble train of little bones and muſcles in man, &c. to ſtrain and relax the membrane, and at the ſame time to open and ſhut the baſis of the Stapes (the ſame as what I call the Operculum in birds). But in birds there is a more ſimple, but ſufficient apparatus for this purpoſe, tender cartilages, inſtead of bones and joints, to correſpond to the various impreſſions of ſounds, and to open and ſhut the Operculum. Beſides which, I ſuſpect the ligament I mention'd, is only the tendon of a muſcle, reaching to the inner Membrana Tympani, and joined thereto (as I find by a ſtricter ſcrutiny) and not to the cartilage, as I imagined. But this for the judging of the food, and that is by peculiar nerves lodged therein for that purpoſe, ſmall, and leſs numerous in ſuch as have the aſſiſtance of another ſenſe, the eye; but large, more numerous, and thickly branched about, to the very end of the beak, in ſuch as hunt for their food out of ſight in the waters, in mud, or under ground (*e*).

And

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muſcle, the inner membrane, and by means of that the outer alſo, can be diſtended or relaxed, as it is in man, by the Malleus and its muſcle, &c.

(*e*) ‘ Flat-bill'd birds, that grope for their meat, have three pair of nerves that come into their bills, whereby they have that accuracy to diſtinguiſh what is proper for food, and what to be rejected by their taſte, when they do not ſee it. This was moſt evident in a duck's bill and head; ducks having larger nerves that come into their bills than geeſe, or any other bird that I have ſeen; and therefore quaffer and grope out their meat the moſt. But then I diſcovered none of theſe nerves in round-bill'd birds. But ſince, in my anatomies in the country, in a rook, I firſt obſerved two nerves that came down betwixt the eyes into the upper bill, but conſiderably ſmaller than any of the three pair of nerves in the bills of ducks, but larger than the nerves of any other round-bill'd birds. And it is remarkable that thoſe birds, more than any other round-bill'd birds, ſeem to grope for their meat in cow-dung, &c.’ Mr. *J. Clayton*, in *Phil. Tranſ.* N° 206.

‘ I obſerved three pair of nerves in all the broad-bill'd birds that I could meet with, and in all ſuch as feel for their food out of ſight, as ſnipes, woodcocks, curlews, geeſe, ducks, teals, widgeons,

‘ &c.

And now from the head and mouth, paſs we to its near ally, the ſtomach, another no leſs notable than uſeful part; whether we conſider the elegancy of its fibres and muſcles, or its multiplicity; one to ſoften and macerate, another to digeſt; or its variety, ſuited to various foods, ſome membranous, agreeable to the frugivorous, or carnivorous kind; ſome muſculous and ſtrong (*f*), ſuited to the comminution, and grinding of corn and grain, and ſo to ſupply the defect of teeth.

And now to this ſpecimen of the parts, I might add many other things, no leſs curiouſly

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‘&c. Theſe nerves are very large, equalling almoſt the optic nerve in thickneſs.---- Two are diſtributed nigh the end of the upper bill, and are there very much expanded, paſſing through the bone into the membrane, lining the roof of the mouth.’ Dr. *A. Moulen,* ibid. N° 199. Or both in Mr. *Lowthorp*'s *Abridg. vol.* II. *p.* 861, 862.

(*f*) The gizzard is not only made very ſtrong, eſpecially in the granivorous; but hath alſo a faculty of grinding what is therein: For which purpoſe, the bird ſwalloweth rough ſtones down, which when grown ſmooth, are rejected and caſt out of the ſtomach, as uſeleſs. This grinding may be heard in falcons, eagles, &c. by laying the ear cloſe to them, when their ſtomachs are empty, as the famous Dr. *Harvey* ſaith, *De generat. Exer.* 7.

As to the ſtrength of the gizzard, and the uſe of ſtones to the digeſtion of fowls, divers curious experiments may be met with, try'd by Signeur *Redi*, with glaſs-bubbles, ſolid glaſs, diamonds, and other hard bodies. See his *Exp. nat.*

ouſly contrived, made, and ſuited to the occaſions of theſe volatiles; as particularly the ſtructure and lodgment of the lungs (*g*); the configuration of the breaſt, and its bone, made like a keel, for commodious paſſage through the air, to bear the large and ſtrong muſcles, which move the wings, and to counterpoiſe the body, and ſupport and reſt it upon at rooſt. The neck alſo might deſerve our notice, always either exactly proportioned to the length of the legs, or elſe longer, to hunt out food,

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(*g*) It is no leſs remarkable in birds, that their lungs adhere to the Thorax, and have but little play, than that in other animals they are looſe, and play much, which is a good proviſion for their ſteady flight. Alſo they want the Diaphragm, and inſtead thereof, have divers large bladders made of thin tranſparent membranes, with pretty large holes out of one into the other. Theſe membranes ſeem to me to ſerve for ligaments, or braces to the Viſcera, as well as to contain air. Towards the upper part, each lobe of the lungs is perforated in two places, with large perforations; whereof one is towards the outer, the other towards the inner part of the lobe. Through theſe perforations the air hath a paſſage into the belly (as in *book* i. *chap.* 1. *note* (*b*) that is, into the foremention'd bladders; ſo that by blowing into the Aſpera Arteria, the lungs will be a little raiſed, and the whole belly blown up, ſo as to be very turgid. Which doubtleſs is a means to make their bodies more or leſs buoyant, according as they take in more or leſs air, to facilitate thereby their aſcents and deſcents; like as it is in the air-bladders of fiſhes in the laſt cited place, note (*i*).

food, to ſearch in the waters (*b*); as alſo to counterpoiſe the body in flight (*i*) And laſtly, I might here take notice of the defect of the Diaphragm, ſo neceſſary in other animals to reſpiration; and alſo of divers other parts redundant, defective, or varying from other animals. But it would be tedious to inſiſt upon all; and therefore to the examples already given, I would rather recommend a nice inſpection (*k*) of theſe curious works of God,

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(*b*) ‘ Such birds as have long legs, have alſo a ‘ long neck; for that otherwiſe they could not commodiouſly gather up their food, either on land, ‘ or in the water. But on the other ſide, thoſe ‘ which have long necks, have not always long ‘ legs, as in ſwans----whoſe necks ſerve them to ‘ reach to the bottom of rivers, &c,’ Willughby’s *Ornithol. l.* 1. *c.* 1. § 7.

(*i*) We have ſufficient inſtances of this in geeſe, ducks, &c. whoſe wings (their bodies being made for the convenience of ſwimming) are placed out of the center of gravity, nearer the head. But the extending the neck and head in flight, cauſeth a due æquipoiſe and libration of the body upon the wings; which is another excellent uſe of the long necks of theſe birds, beſides that of reaching and ſearching in the waters for their food,

But in the Heron, whoſe head and long neck (although tuck’d up in flight) over-balance the hinder part of the body; the long legs are extended in flight, to counterpoiſe the body, as well as to ſupply what is wanting in the tail, from the ſhortneſs of it.

(*k*) *Steno* thus concludes his myology of the eagle, God, which would be manifeſt demonſtrations of the admirable contrivance and œconomy of the bodies of thoſe creatures.

From the fabrick therefore of their bodies, I ſhall paſs to a glance of one or two things relating to their ſtate; and ſo conclude this genus of the animal world.

'Imperfecta hæc muſculorum deſcriptio, non minùs arida eſt legentibus, quàm inſpectantibus 'fuerit jucunda eorumdem præparatio. Elegantiſſima enim mechanices artificia, creberrimè in 'illis obvia, verbis non niſi obſcurè exprimuntur, 'carnium autem ductu, tendinum colore, inſertionum proportione, & trochlearum diſtributione 'oculis expoſita omnem ſuperant admirationem.' Steno *in Blaſ. anat. animal. p.* 2. *c.* 4.

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CHAP. III.

Of the Migration of Birds.

Concerning the ſtate of this tribe of animals, the firſt thing I ſhall ſpeak of (by reaſon God himſelf inſtanceth in it) ſhall be their migration, mentioned *Jer.* viii. 7. 'Yea, 'the ſtork in the heaven knoweth her appointed times, and the turtle, and the crane, 'and the ſwallow obſerve the time of their 'coming; but the people, &c.'

In which act of migration, there are two things to me exceedingly notable. One is what the text ſpeaks of, their knowing their pro-

proper times for their paſſage, when to come (*a*), when to go; as alſo that ſome ſhould come, when others go; and ſome others go, when theſe come. There is no doubt but the temperature of the air, as to heat and cold, and their natural propenſity to breed their young, may be great incentives to thoſe creatures to change their habitation: But yet it is a very odd inſtinct, that they ſhould at all ſhift their habitation; that ſome certain place is not to be found in all the terraqueous globe, affording them convenient food and habitation all the year, either in the colder climes, for ſuch as delight in the colder regions; or the hotter, for ſuch birds of paſſage as fly to us in ſummer.

Alſo it is ſomewhat ſtrange, that thoſe untaught, unthinking creatures, ſhould ſo exactly know the beſt and only proper ſeaſons to go and come. This gives us good reaſon to interpret the מועדיה *appointed times* (*b*) in the text, to be ſuch times as the creator hath ap-

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(*a*) ‘Curioſa res eſt, ſcire, quam exactè hoc genus avium [gruum] quotannis obſervet tempora ſui reditûs ad nos. Anno 1667, primæ grues comparuerunt in campeſtribus Piſæ 20 Feb. &c.’ F. Redi *exp. nat. p.* 100. *ubi plura.*

(*b*) From ‘יעד indixit, conſtituit, ſcil. locum, vel tempus, ubi vel quando aliquid fieri debet.’ Buxt. *in verb.*

‘De voluntate ſuâ certiorem reddidit.’ C. Kircher *Concordant. pars* 1. *col.* 1846. ‘מועד generali-
‘ter

appointed thoſe animals, and hath accordingly, for this end, imprinted upon their natures ſuch an inſtinct, as exciteth and moveth them thus, at proper times, to fly from a place that would obſtruct their generation, or not afford convenient food for them, and their young, and betake themſelves to another place, affording all that is wanting for food or incubation.

And this leads me to another thing remarkable in this act of migration; and that is, that thoſe unthinking creatures ſhould know what way to ſteer their courſe (*c*), and whither to go. What, but the great Creator's inſtinct,

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'ter pro re aliquâ certâ, atteſtatâ, & definitâ accipitur. 1. Pro tempore certo & conſtituto. 2. Deinde pro feſto ſeu ſolennitate, quæ certo & ſtato tempore celebratur. 3. Pro loco certo conſtituto. *Id. ibid. col.* 1847.

(*c*) 'Quis non cum admiratione videat ordinem & politiam peregrinantium avium, in itinere, turmatim volantium, pro longos terrarum & maris tractus abſque acu marinâ?-----Quis eas certum iter in aëris mutabili regione docuit? Quis præteritæ ſigna, & futuræ viæ indicia? Quis eas ducit, nutrit, & vitæ neceſſaria miniſtrat? Quis inſulas & hoſpitia illa, in quibus victum reperiant, indicavit; modumque ejuſmodi loca in peregrinationibus ſuis inveniendi? Hæc ſanè ſuperant hominum captum & induſtriam, qui non niſi longis experientiis, multis itinerariis, chartis geographicis,------& acûs magneticæ beneficio,-----ejuſmodi marium & terrarum tractus conficere tentant & audent.' Lud. *de Beaufort, coſm. divina,* § 5. *cap.* 1.

inſtinct, ſhould ever move a poor fooliſh bird, to venture over vaſt tracts of land, but eſpecially over large ſeas? If it ſhould be ſaid, that by their high aſcent up into the air, they can ſee croſs the ſeas; yet what ſhould teach or perſuade them, that that land is more proper for their purpoſe than this? That Britain (for inſtance) ſhould afford them better accommodations than Egypt (*d*), than the Canaries, than Spain, or any of thoſe many intermediate

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(*d*) I inſtance particularly in *Egypt*, becauſe Mr. *Willughby* thinks Swallows fly thither, and into *Ethiopia*, &c. and that they do not lurk in holes, or under water, as *Olaus Magnus* reports. *Vide Ornith. lib.* 2. *cap.* 3. But *Etmuller* puts the matter out of doubt, who ſaith, ‘Memini me plures, quàm quas medimnus caperet, Hirundines arctè coacervatas intra piſcinæ cannas, ſub glacie prorſus ad ſenſum exanimes, pulſantes tamen, reperiiſſe.’ Etmuller *Diſſert.* 2. *cap.* 10. §. 5. This, as it is like what *Ol. Magnus* ſaith, ſo is a confirmation of it. The Archbiſhop's account is, ‘In ſeptentrionalibus aquis ſæpius caſu piſcatoris extrahuntur Hirundines, in modum conglomeratæ maſſæ, quæ ore ad os, & alâ ad alam, & pede ad pedem poſt poſt principium autumni ſeſe inter cannas deſcenſuræ colligârunt.-----Maſſa autem illa per imperitos adoleſcentes-----extracta, atque in æſtuaria portata, caloris acceſſu Hirundines reſolutæ, volare quidem incipiunt, ſed exiguo tempore durant.’ Ol. Mag. *hiſt. l.* 19. *c.* 20.

Since my penning this note, we had, at a meeting of the Royal Society, *Feb.* 12, 1712-13, a farther confirmation of Swallows retiring under water in termediate places over which ſome of them probably fly?

And laſtly, to all this, let us briefly add the accommodations theſe birds of paſſage have, to enable them to take ſuch long flights; viz. the length of their wings, or their more than ordinary ſtrength (*e*) for flight.

CHAP.

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in winter, from Dr. *Colas*, a perſon very curious in theſe matters; who ſpeaking of their way of fiſhing in the northern parts, by breaking holes, and drawing their nets under the ice, ſaith, That he ſaw ſixteen Swallows ſo drawn out of the lake of *Samrodt*, and about thirty out of the King's great pond in *Roſineilen*; and that at *Schlebitten*, near an houſe of the Earl of *Dohna*, he ſaw two Swallows juſt come out of the waters, that could ſcarce ſtand, being very wet and weak, with their wings hanging on the ground; and that he hath obſerv'd the Swallows to be often weak for ſome days after their appearance.

(*e*) As Swallows are well accommodated for long flights, by their long wings, ſo are Quails by the ſtrength of their pectoral muſcles, by the breadth of their wings, &c. For Quails have but ſhort wings for the weight of their body; and yet they fly from us into warmer parts againſt winter, and to us in ſpring, croſſing our ſeas. So divers travellers tell us, they croſs the *Mediterranean* twice a year, flying from *Europe* to *Africa*, and back again: Thus *Bellonius* in Mr. *Willughby* ſaith, 'When we ſail'd 'from *Rhodes* to *Alexandria* of *Egypt*, many Quails 'flying from the north towards the ſouth, were 'taken in our ſhip; whence I am verily perſuaded 'that they ſhift places: For formerly alſo, when

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CHAP. IV.

Of the Incubation of Birds.

ANother thing relating to the ſtate of this tribe of animals, is their incubation.

And firſt, the egg itſelf deſerves our notice. Its parts within, and its cruſty coat without, are admirably well fitted for the buſineſs of incubation. That there ſhould be one part provided for the formation of the body (*a*) before its exit into the world, and another for its

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‘I ſail'd out of the Iſle of *Zant* to *Morea*, or *Negropont*, in the ſpring-time, I had obſerv'd Quails flying the contrary way, from ſouth to north, that they might abide there all ſummer. At which time alſo, there were a great many taken in our ſhip.’ *Ornith. p.* 170.

(*a*) ‘The chicken is form'd out of, and nouriſh'd by the white alone, till it be grown great. The yolk ſerves for the chicken's nouriſhment after it is well grown, and partly alſo after it is hatch'd. For a good part of the yolk remains after excluſion, being receiv'd into the chicken's belly and being there reſerved, as in a ſtore-houſe, is by the [Appendicula, or Ductus Inteſtinalis] as by a funnel, convey'd into the guts, and ſerves inſtead of milk, &c.’ Willughby's *Ornith. l.* 1. *c.* 3. ‘Ipſum animal ex albo liquore ovi corporatur. Cibus ejus in luteo eſt.’ Plin. *lib.* 10. *cap.* 53.

Ariſtotle ſaith, ‘The long ſharp eggs bring females; the round ones, with a larger compaſs at its nouriſhment, after it is come into the world, till the bird is able to ſhift for, and help itſelf; and that theſe parts ſhould be ſo accurately braced, and kept in due place (*b*), is certainly a deſign'd, as well as curious piece of workmanſhip.

And

'at the ſharper end, males.' *Hiſt. an. l.* 6. *c.* 2. After which, he tells of a ſot at *Syracuſe*, that ſat drinking ſo long, till eggs were hatch'd; as alſo of the cuſtom of *Egypt*, of hatching on dunghills.

(*b*) As the ſhell and ſkin keep the yolk and two whites together; ſo each of the parts (the yolk and inner white at leaſt) are ſeparated by membranes, involving them. At each end of the egg is a treddle, ſo call'd, becauſe it was formerly thought to be the ſperm of the cock. 'But the uſe of theſe (ſaith Dr. *Harvey*, in *Willugh. Ornith. c.* 3.) 'is to 'be as it were the poles of this microcoſm, and 'the connexions of all the membranes twiſted and 'knit together, by which the liquors are not only 'conſerved, each in its place, but do alſo retain 'their due poſition one to another.' This, although in a great meaſure true, yet do not come up to what I have myſelf obſerved; for I find, that theſe Chalazæ, or Treddles, ſerve not barely to keep the liquors in their place, and poſition to one another; but alſo to keep one and the ſame part of the yolk uppermoſt, let the egg be turn'd nearly which way it will; which is done by this mechaniſm: The Chalazæ are ſpecifically lighter than the whites, in which they ſwim; and being braced to the membrane of the yolk, not exactly in the axis of the yolk, but ſomewhat out of it, cauſeth one ſide of the yolk to be heavier than the other; ſo

And then as to the act itſelf of incubation, what a prodigious inſtinct is it in all, or almoſt all the ſeveral ſpecies of birds, that they, and only they, of all creatures, ſhould betake themſelves to this very way of generation? How ſhould they be aware that their eggs contain their young, and that their production is in their power (*c*)? What ſhould move them to betake themſelves to their neſts, and there with delight and patience to abide the due number of days? And when their young are gotten into the world, I have already ſhewn how admirable their art, their care, and Στοργὴ, is in bringing them up until, and only until, they are able to ſhift for themſelves.

And laſtly, when almoſt the whole tribe of birds do thus, by incubation, produce their young, it is a wonderful deviation, that ſome few families only ſhould do it in a more novercal way (*d*), without any care or trouble

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ſo that the yolk being by the Chalazæ made buoyant, and kept ſwimming in the midſt of two whites, is by its own heavy ſide kept with the ſame ſide always uppermoſt; which uppermoſt ſide, I have ſome reaſon to think, is that on which the Cicatricula lies; that being commonly uppermoſt in the ſhell, eſpecially in ſome ſpecies of eggs more, I think, than others.

(*c*) All birds lay a certain number of eggs, or nearly that number, and then betake themſelves to their incubation; but if their eggs be withdrawn, they will lay more. Of which ſee Mr. Ray's *Wiſdom of God*, *p.* 137.

(*d*) The Tahon is a bird no bigger than a chicken, at all, only by laying their eggs in the ſand, expoſed to the heat and incubation of the ſun. Of this the holy ſcripture itſelf gives us an inſtance in the oſtrich: of which we have an hint, *Lam.* iv. 3. 'The daughter of my peo-'ple is become cruel, like the oſtriches in the 'wilderneſs.' This is more plainly expreſſed in *Job* xxxix. 14, 15, 16, 17. '[The Oſ-'trich] leaveth her eggs in the earth, and 'warmeth them in the duſt, and forgetteth 'that the foot may cruſh them, or that the 'wild beaſt may break them. She is hardened 'againſt her young ones, as though they were 'not hers: Her labour is in vain, without 'fear,'

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but is ſaid to lay an egg larger than a gooſe's egg, and bigger than the bird itſelf. Theſe they lay a yard deep in the ſand, where they are hatched by the warmth of the ſun; after which they creep out, and get to ſea for proviſions. Navaret's *account of* China, *in collect. of voyages, vol.* I. This account is in all probability borrowed from *Nieremberg*, or *Hernandez* (that copied from him) who calls this bird by the name of Daie, and its eggs Tapun, not the bird itſelf, as *Navarette* doth. But my friend Mr. *Ray* ſaith of it, 'Hiſtoria iſthæc proculdubio 'fabuloſa & falſa eſt. Quamvis enim aves non-'nullæ maxima ova pariunt, ut v. g. Alkæ, Lom-'wiæ, Anates, Arcticæ, &c. hujuſmodi tamen 'unum duntaxat, non plura, ova ponunt ante-'quam incubent: nec ullam in rerum naturâ avem 'dari exiſtimo cujus ova albumine careant. Cum 'albumen præcipua ovi pars ſit, quodque primum 'fœtui alimentum ſubminiſtrat,' Raii *Synopſ. av. meth. p.* 155.

'fear, becauſe God hath deprived her of wiſdom, neither hath he imparted unto her underſtanding.' In which words I ſhall take notice of three things: 1. Of this anomalous way of generation. It is not very ſtrange, that no other incubation but that of the ſun, ſhould produce their young, but it is very odd and wonderful that any one ſpecies ſhould vary from all the reſt of the tribe. But above all, 2. The ſingular care of the Creator, in this caſe, is very remarkable. in ſupplying ſome other way, the want of the parent-animal's care and Στοργὴ (e), ſo that the young ſhould, notwithſtanding, be bred up in thoſe large and barren deſerts of Arabia and Africa, and ſuch like places where thoſe birds dwell, the moſt unlikely and unfitting (in all human opinion) to afford ſuſtenance to young helpleſs creatures; but the fitteſt therefore to give demonſtrations of the wiſdom, care, and eſpecial

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(e) 'The eggs of the Oſtrich, being buried in the ſand, are cheriſhed only by the heat of the ſun, till the young be excluded: For the writers of natural hiſtory do generally agree, that the old birds, after they have laid and covered their eggs in the ſand, forſake them, and take no more care of them.' Willugh. *Ornith. l.* 2. *c.* 8. § 1.

But there is another Oſtrich [of *America*] which *Acaret* tells us of, that takes more care of her young, by carrying four of her eggs, a little before ſhe hatcheth, to four parts of her neſt, there to breed worms for food for her young. Acaret's *Diſc.* in *Philoſ. Tranſ.* N° 89.

cial providence of the infinite Creator and conſervator of the world. 3. The laſt thing I ſhall remark is, that the inſtincts of irrational animals, at leaſt of this ſpecified in the text, are attributed to God. For the reaſon the text gives why the 'Oſtrich is hardened 'againſt her young ones, as though they were 'not hers,' is, 'Becauſe God hath deprived 'her of wiſdom, and not imparted under'ſtanding to her;' i. e. he hath denied her that wiſdom, he hath not imparted that underſtanding, that Στοργὴ, that natural inſtinct, to provide for and nurſe up her young, that moſt other creatures of the ſame, and other tribes are endowed with.

Thus I have diſpatched what I intended to inſiſt upon concerning the ſtate of this ſet of animals; which, as alſo of their admirable inſtincts, a great deal more might deſerve our eſpecial obſervation; particularly the admirable curioſity, art, and variety of nidification (*f*), uſed among the various ſpecies of birds; the great ſagacity, and many artifices uſed by them in the inveſtigation and capture of their prey (*g*), the due proportion of the more and leſs uſeful, the ſcarcity of the voracious and pernicious, and the plenty of the manſuete and uſeful (*h*). Alſo the variety of their motion and flight might deſerve conſideration, the ſwiftneſs of ſuch whoſe food is to be

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(*f*) See *book* iv. *chap.* 13.
(*g*) See *book* iv. *chap.* 11. *and* 14.
(*h*) See *book* iv. the beginning of *chap.* 10.

be ſought in far diſtant places, and different ſeaſons (*i*); the ſlower motion, and ſhort flights, of others more domeſtick; and even the aukwardneſs of ſome others to flight, whoſe food is near at hand, and to be gotten without any great occaſion of flight (*k*). Theſe, and divers other ſuch like things as theſe, I ſay, I might have ſpoken more largely unto; but I ſhall paſs them by with only a bare mention, having already taken notice of them, in the company of other matters of the like nature, and manifeſted them to be acts of excellent deſign, wiſdom and providence, in the great Creator.

CHAP. V.

The CONCLUSION.

AND now, if we reflect upon the whole matter, we ſhall here find another large tribe of the Creation, abundantly ſetting forth the wiſdom and glory of their great Creator. We praiſe the ingenuity and invention of men, for

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(*i*) See *book* iv. *chap*. 8.

(*k*) The Colymbi, or Douckers, having their food near at hand in the waters, are remarkably made for diving therein. Their heads are ſmall, bills ſharp pointed, wings ſmall, legs flat and broad, and placed backward, and nearer the tail than in other birds; and laſtly, their feet, ſome are whole-footed, ſome cloven-footed, but withal fin-toed.' *Vide* Willughby *Ornith*. *l*. 3. § 5.

for the contrivance of various pneumatick engines; we think them witty, even for their unſucceſsful attempts to ſwim in, and ſail through that ſubtile element the air; and the curious mechaniſm of that artiſt is had in remembrance, and praiſed to this day, who made a dove, or an eagle (*a*) to fly but a ſhort ſpace. And is not therefore all imaginable honour and praiſe due to that infinite artiſt, that hath ſo admirably contrived and made all the noble variety of birds; that hath with ſuch incomparable curioſity and art, formed their bodies from head to tail, without and within, that not ſo much as any muſcle, or bone, no, not even a feather (*b*) is unartificially made, miſplaced, redundant, or defective, in all the ſeveral families of this large tribe? but every thing is ſo incomparably performed, ſo nicely fitted up for flight, as to ſurpaſs even the imitation of the moſt ingenious artificer among mortal rational beings.

(*a*) Vide *book* v. *chap.* 1. *note* (*aa*).

(*b*) 'Deus non ſolum angelum, & hominem, ſed 'nec exigui & contemptibilis animantis viſcera, 'nec avis pennulam, nec herbæ floſculum, nec arboris folium, ſine ſuarum partium convenientiâ 'dereliquit.' Auguſtin. *de civ. Dei, l.* 5. *c.* 11.

BOOK

BOOK VIII.

Of INSECTS and REPTILES.

CHAP. I.

Of INSECTS in general.

HAVING diſpatch'd that part of the animal world, which uſed to be accounted the more perfect, thoſe animals ſtiled leſs perfect, or imperfect, will next deſerve a place in our Survey, becauſe when ſtrictly enquired into, we ſhall find them to be ſo far from deſerving to be accounted mean and deſpicable parts of the creation, owing their original and production to putrefactions, &c. as ſome have thought, that we ſhall find them, I ſay, noble, and moſt admirable works of God. For, as the famous natural hiſtorian, *Pliny* (*a*), prefaceth his Treatiſe of Inſects, to prevent the reproach of condeſcending (as might be thought) to ſo mean a ſubject: 'In great bodies, ſaith he, nature had a large 'and eaſy ſhop to work upon obſequious mat'ter; whereas, in theſe ſo ſmall, and as it 'were no bodies, what footſteps of reaſon, 'what

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(*a*) 'In magnis ſiquidem corporibus, &c.' Plin. *nat. hiſt. l.* 11. *c.* 2.

‘ what power, what great perfection is there ?’ Of this having given an inſtance or two of the exquiſite ſenſes, and curious make of ſome inſects (*b*), he then goes on ; ‘ We admire, ‘ ſaith he, the turrigerous ſhoulders of elephants, the lofty necks and creſts of others ; ‘ but, ſaith he, the nature of things is never ‘ more compleat than in the leaſt things.’ For which reaſon he intreats his readers (as I do mine) ‘ that becauſe they ſlighted many of ‘ the things themſelves which he took notice ‘ of, they would not therefore diſdainfully ‘ condemn his accounts of them, ſince, ſaith ‘ he, in the contemplation of nature, nothing ‘ ought to ſeem ſuperfluous.’

(*b*) ‘ Ubi tot ſenſus collocavit in culice ? Et ſunt ‘ alia dictu minora. Sed ubi viſum in eo prætendit ? Ubi guſtatum applicavit ? Ubi odoratum inſeruit ? Ubi verò truculentam illam & portione ‘ maximam vocem ingeneravit ? Quâ ſubtilitate ‘ pennas adnexuit ? Prælongavit pedum crura ? ‘ Diſpoſuit jejunam caveam, uti alvum ? Avidam ‘ ſanguinis, & potiſſimum humani, ſitim, accendit ? ‘ Telum verò perfodiendo tergori, quo ſpiculavit ‘ ingenio ? Atque ut in capaci, cùm cerni non poſſit exilitas, ita reciprocâ geminavit arte, ut fodiendo acuminatum pariter ſorbendoque fiſtuloſum eſſet. Quos teredini ad perforanda robora ‘ cum ſono teſte dentes affixit ? Potiſſimumque è ‘ ligno cibatum fecit. Sed turrigeros elephantorum miramur humeros, taurorumque colla, & ‘ truces in ſublime jactus, tigrium rapinas, leonum ‘ jubas, cùm rerum natura nuſquam magis quàm in ‘ minimis, tota ſit.’ Plin. *ibid.*

Thus that eminent naturaliſt hath made his own, and my excuſe too; the force and verity whereof will farther appear, by what I ſhall ſay of theſe animals, which (as deſpicable as they have been, or perhaps may be thought) we ſhall find as exquiſitely contrived, and curiouſly made for that place and ſtation they bear in the world, as any other part of the animal world. For if we conſider the innumerable variety of their ſpecies, the prodigious numbers of individuals, the ſhape and make of their little bodies, and every part thereof, their motion, their inſtincts, their regular generation and production; and, to name no more, the incomparable beauty and luſtre of the colours of many of them, what more admirable and more manifeſt demonſtration of the infinite Creator, than even this little contemned branch of the animal world? But let us take a ſhort view of particulars.

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CHAP. II.

Of the Shape and Structure of Inſects.

LET us begin with the ſhape and fabrick of their bodies: which altho' it be ſomewhat different from that of birds, being particularly, for the moſt part, not ſo ſharp before, to cut and make way through the air, yet is better adapted to their manner of life. For conſidering that there is little neceſſity of long

long flights, and that the ſtrength and activity of their wings doth much ſurpaſs the reſiſtance their bodies meet with from the air, there was no great occaſion their bodies ſhould be ſo ſharpened before. But the condition of their food, and the manner of gathering it, together with the great neceſſity of accurate viſion, by that admirable proviſion made for them by the reticulated Cornea of their eyes; theſe things, I ſay, as they required a larger room, ſo were a good occaſion for the largeneſs of the head, and its amplitude before. But for the reſt of their body, all is well made, and nicely poiſed for their flight, and every other of their occaſions.

And as their ſhape, ſo the fabrick and make of their bodies is no leſs accurate, admirable, and ſingular; not built throughout with bones, and cover'd with fleſh and ſkin, and in moſt other animals; but cover'd with a curious mail of a middle nature (*a*), ſerving both as ſkin and bone too, for the ſhape, as well as ſtrength and guard, of the body; and as it were on purpoſe to ſhew, that the great contriver of nature is not bound up to one way only.

(*a*) 'Inſecta non videntur nervos habere, nec 'oſſa, nec ſpinas, nec cartilaginem, nec pinguia, 'nec carnes, nec cruſtam quidem fragilem, ut quædam marina, nec quæ jure dicatur cutis: ſed mediæ cujuſdam inter omnia hæc naturæ corpus, &c.' Plin. *nat. hiſt. l.* 11. *c.* 4.

CHAP.

CHAP. III.

Of the Eyes and Antennæ of Inſects.

TO this laſt-mentioned guard, we may add, that farther guard provided in the eyes and Antennæ. The ſtructure of the eye is, in all creatures, an admirable piece of mechaniſm; but that obſervable in the eyes of inſects ſo peculiar, that it muſt needs excite our admiration: Fenced with its own hardneſs, yea, even its own accurate viſion, is a good guard againſt external injuries; and its Cornea, or outward coat, all over beſet with curious, tranſparent lenticular (*a*) inlets, enabling

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(*a*) The Cornea of flies, waſps, &c. are ſo common an entertainment with the microſcope, that every body knows, it is a curious piece of lattice-work. In which this is remarkable, that every Foramen is of a lenticular nature; ſo that we ſee objects through them topſey-turvey, as through ſo many convex glaſſes: yea, they become a ſmall teleſcope, when there is a due focal diſtance between them and the Lens of the microſcope.

This lenticular power of the Cornea ſupplies (as I imagine) the place of the cryſtalline, if not of the vitreous humour too, there being neither of thoſe humours that I could ever find (although for truth ſake, I confeſs I have not been ſo diligent as I might in this enquiry) but inſtead of humours and tunicks, I imagine that every Lens of the Cornea hath a diſtinct branch of the Optic Nerve miniſtring to it, and rendring it as ſo many diſtinct eyes. So that abling thoſe creatures to ſee (no doubt) very accurately every way, without any interval of time or trouble to move the eye towards objects.

And as for the other part, the Antennæ, or Feelers, whatever their uſe may be in cleaning the eyes, or other ſuch like uſe; they are, in all probability, a good guard to the eyes and head, in their walk and flight, enabling them, by the ſenſe of feeling, to diſcover ſuch annoyances, which by their proximity may perhaps eſcape the reach of the eyes and ſight (*b*). Beſides which, they are a curious piece

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that as moſt animals are binocular, ſpiders for the moſt part octonocular, and ſome (as Mr. *Willughby* thought, *Raii hiſt. inſect. p.* 12.) ſenocular; ſo flies, &c. are multocular, having as many eyes as there are perforations in their Corneæ. By which means, as other creatures are obliged to turn their eyes to objects, theſe have ſome or other of their eyes ready placed towards objects, nearly all round hem: Thus particularly it is in the Dragon-fly (Libella) the greateſt part of whoſe head is poſſeſſed by its eyes: which is of excellent uſe to that predatious inſect, for the ready ſeeing and darting at ſmall flies all round it, on which it preys.

(*b*) It is manifeſt, that inſects clean their eyes with their fore-legs, as well as Antennæ. And conſidering, that as they walk along, they are perpetually feeling, and ſearching before them with their feelers, or Antennæ; therefore I am apt to think, that beſides wiping and cleaning the eyes, the uſes here named may be admitted. For as their eyes piece of workmanſhip, and in many, a very beautiful piece of (*c*) garniture to the body

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eyes are immovable, ſo that no time is required for the turning their eyes to objects; ſo there is no neceſſity of the Retina, or Optick Nerve being brought nigher unto, or ſet farther off from the Cornea (which would require time) as it is in other animals: but their Cornea and Optic Nerve being always at one and the ſame diſtance, are fitted only to ſee diſtential objects, but not ſuch as are very nigh: which inconvenience the feelers obviate, leſt it ſhould be prejudicial, in occaſioning the inſect to run its head againſt any thing.

And that this, rather than the wiping the eyes, is the chief uſe of the feelers, is farther manifeſt from the Antennæ of the Fleſh-fly, and many other inſects, which are ſhort, and ſtrait, and incapable of being bent unto, or extended over the eyes: as alſo from others enormouſly long, ſuch as thoſe of the Capricorni, or Goat-chafers, the Cadew-fly, and divers others, both beetles and flies.

(*c*) The lamellated Antennæ of ſome, the clavellated of others, the neatly articulated of others, the feather'd and divers other forms of others, of the Scarab, Papilonaceous Gnat, and other kinds, are ſurprizingly beautiful, when viewed through a microſcope. And in ſome, thoſe antennæ diſtinguiſh the ſexes: as in the gnat-kind, all thoſe with tufts, feathers, and bruſh-horns, are males; thoſe with ſhort, ſingle-ſhafted Antennæ, are females.

C H. A P. IV.

Of the Parts and Motion of Inſects.

FROM the head paſs we to the members concerned in their motion. And here we have a copious ſubject, if I was minded to expatiate. I might take notice of the admirable mechaniſm in thoſe that creep; the curious oars in thoſe amphibious inſects that ſwim and walk (*a*); the incomparable proviſion made in the feet of ſuch as walk, or hang upon ſmooth ſurfaces (*b*); the great ſtrength and ſpring

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(*a*) All the families of Hydrocanthari, Notonecti, &c. have their hindmoſt legs made very nicely, with commodious joints flat, and briſtles on each ſide towards the end, ſerving for oars to ſwim; and then, nearer the body, are two ſtiff ſpikes, to enable them to walk, when occaſion is.

(*b*) I might here name divers flies, and other inſects, who, beſides their ſharp hooked nails, have alſo ſkinny palms to their feet, to enable them to ſtick on glaſs, and other ſmooth bodies, by means of the preſſure of the atmoſphere. But becauſe the example will illuſtrate another work of nature, as well as this, I ſhall chuſe a ſingular piece of mechaniſm, in one of the larger ſorts of Hydrocanthari. Of theſe large ones, there are two ſorts, one largeſt, all black, with Antennæ handſomely emboſſed at the ends. The other ſomewhat leſſer, hardly ſo black, with capillary Antennæ; the forehead, edges of the Vaginæ, and two rings on the Thorax, ſpring in the legs of ſuch as leap (*c*); the ſtrong and well-made feet and talons of ſuch as dig (*d*): And, to name no more, the admirable faculty of ſuch as cannot fly, to convey themſelves with ſpeed and ſafety, by the help of their webs (*e*), or ſome other artifice,

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Thorax, of a tawny colour. The female hath Vaginæ prettily furrow'd, the male ſmooth. But that which is moſt to our purpoſe, in this male is a flap, or hollowiſh cap, near the middle joint of the fore-legs, which, when clapped on the ſhoulders of the female *in coitu*, ſticks firmly thereon: after the manner as I have ſeen boys carry heavy ſtones, with only a wet piece of leather clapped on the top of the ſtone.

(*c*) Thus Graſhoppers and Crickets have brawny ſtrong thighs, with long, ſlender, but ſtrong legs, which enable them to leap with great agility and ſtrength.

(*d*) I have wonder'd to ſee with what great quickneſs, art, and ſtrength, many Veſpæ-Ichneumons, Wild-bees, and beetles, perforate the earth, yea, even wood itſelf: But the moſt remarkable animal in this way, is the Mole-cricket, in *book* iv. *chap*. 13. *note* (*s*).

(*e*) I have with pleaſure often ſeen ſpiders dart out their webs, and ſail away by the help thereof. For the manner of which, ſee *Lowthorp*'s *Abridg. vol.* II. *p.* 794. from Dr. *Liſter* and Dr. *Hulſe*, who both claimed the diſcovery thereof. And both do ſeem to have hit thereupon, without any fore-knowledge of what each other hath diſcovered, as is ſaid in the laſt-cited place, and as I more particularly find by Mr. *Ray*'s *Philoſ. Letters*, printed *anno* fice, to make their bodies lighter than the air (*f*): Theſe, and a multitude of other ſuch like

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1718, *p.* 95, &c. By which alſo I find, the two ingenious doctors were very modeſt in their claims, and very amicable in the matter. In one of Dr. *Liſter*'s to Mr. *Ray*, he thinks there is a fair hint of the darting of ſpiders in Ariſt. *hiſt. an. l.* 9. *c.* 39. And in Pliny, *l.* 11. *c.* 24. But for their ſailing, that the ancients are ſilent of, and he thinks it was ſeen firſt by him. And in another letter, *Jan.* 20, 1670, ſpeaking of the height ſpiders are able to fly, he ſaith, 'The laſt *October*, &c. I took notice that 'the air was very full of webs, I forthwith moun'ted to the top of the higheſt ſteeple on the *Minſter* '[in *York*] and could thence diſcern them yet ex'ceeding high above me. Some that fell, and were 'entangled upon the pinnacles, I took, and found 'them to be Lupi; which kind ſeldom or never 'enter houſes, and cannot be ſuppoſed to have 'taken their flight from the ſteeple.'

(*f*) There are, I imagine, divers animals, as well as ſpiders, that have ſome way of conveyance, as little known to us as that of ſpiders formerly was. Thus the Squillulæ, Pulices Arboreſcentes, and microſcopical Animalcules of the ſtagnating waters, ſo numerous in them, as to diſcolour ſometimes the waters, and make them look as if they were tinged red, yellow, or green, or covered with a thick green ſcum; all which is nothing but animalcules of that colour. That theſe creatures have ſome way of conveyance, I conclude, becauſe moſt ſtagnating waters are ſtocked with them, new pits and ponds, yea, holes and gutters on the tops of houſes and ſteeples. That they are not bred there by like things as theſe, I might, I ſay, take notice of, as great evidences of the infinite Creator's wiſdom: But leſt I ſhould be too tedious, I will confine my obſervations to the legs and wings only. And theſe, at firſt view, we find to be incomparably fitted up for their intended ſervice, not to over-load the body, nor in the leaſt to retard it; but to give it the moſt proper and convenient motion. What, for example, can be better contrived, and made for this ſervice, than the wings? diſtended and ſtrength-

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by equivocal generation, every ingenious, conſidering philoſopher will grant; that they have not legs for travelling ſo far, is manifeſt from inſpection: and therefore I am apt to think, that they have ſome faculty of inflating their bodies, or darting out webs, and making their bodies buoyant, and lighter than air, or their bodies, when dry, may be lighter than air, and ſo they can ſwim from place to place; or the eggs of ſuch as are oviparous, may be light enough to float in the air. But then the viviparous (as my late ingenious friend Mr. *Charles King*, ſhewed me the *Pulices Aquat. Arboreſ.* are; theſe, I ſay,) can't be this way accounted for. The cauſe of theſe latter ſuſpicions was, that in the ſummer months, I have ſeen the Pulices Arboreſ. and the green ſcum on the waters (nothing but animalcules, as I ſaid,) lie in a manner dry on the ſurface of the waters; at which time (as I have ſhewn in *book* iv. *chap.* 11. *note* (*n*). thoſe animalcules copulate; and perhaps they may at the ſame time change their quarters, and ſeek out new habitations for their numerous offſpring, as well as themſelves.

ſtrengthened by the fineſt bones, and theſe covered with the fineſt and lighteſt membranes, ſome of them adorned with neat and beautiful feathers (*g*); and many of them provided with the fineſt articulations, and foldings, for the wings to be withdrawn, and neatly laid up in their Vaginæ, and caſes, and again readily extended for flight (*b*).

And then for the poiſing of the body, and keeping it upright, and ſteady in flight, it is an admirable artifice and proviſion for this purpoſe; in ſome, by four wings (*i*); and in ſuch

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(*g*) It is well known to all perſons any way converſant in microſcopical obſervations, that theſe elegant colours of Moths and Butterflies, are owing to neat and well-made feathers, ſet with great curioſity and exactneſs in rows, and good order.

(*b*) All that have Elytra, Scarabs (who have whole Elytra, or reaching to the Podex, or the Ἡμικȣλεόπτεροι, ſuch as Earwigs, and Staphilini of all ſorts) do, by a very curious mechaniſm, extend and withdraw their membranaceous wings (wherewith they chiefly fly) and it is very pretty to ſee them prepare themſelves for flight, by thruſting out, and unfolding their wings, and again withdraw thoſe joints, and neatly fold in the membranes, to be laid up ſafely in their Elytra or caſes. For which ſervice the bones are well placed, and the joints miniſtring thereunto are accurately contrived, for the moſt compendious and commodious folding up the wings.

(*i*) For the keeping the body ſteady and upright in flight, it generally holds true (if I miſtake not) that all bipennated inſects have poiſes joined to the body, ſuch as have but two, by pointels, and poiſes placed under the wings, on each ſide the body.

And laſtly, it is an amazing thing to reflect upon the ſurprizing minuteneſs, art, and curioſity of the (*k*) joints, the muſcles, the tendons, the nerves, neceſſary to perform all the motions of the legs, the wings, and every other part. I have already mentioned this in the larger animals; but to conſider, that all theſe things concur in minute animals, even in the

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body, under the hinder part of their wings; but ſuch as have four wings, or wings with Elytra, none. If one of the poiſes, or one of the leſſer auxiliary wings be cut off, the inſect will fly as if one ſide over-balanced the other, until it falleth on the ground; ſo if both be cut off, they will fly aukwardly, and unſteadily, manifeſting the defect of ſome very neceſſary part. Theſe poiſes, or pointels, are, for the moſt part, little balls, ſet at the top of a ſlender ſtalk, which they can move every way at pleaſure. In ſome they ſtand alone, in others (as in the whole fleſh-fly tribe) they have little covers, or ſhields, under which they lie and move. The uſe, no doubt, of theſe poiſes, and ſecondary leſſer wings, is to poiſe the body, and to obviate all the vacillations thereof in flight; ſerving to the inſect, as the long pole, laden at the ends with lead, doth the Rope-dancer.

(*k*) As all the parts of animals are moved by the help of theſe; ſo there is no doubt but the minuteſt animals have ſuch like parts: But the muſcles and tendons of ſome of the larger inſects, and ſome of the leſſer too, may be ſeen with a microſcope.

the ſmalleſt mite; yea, the animalcules, that (without good microſcopes) eſcape our ſight; to conſider, I ſay, that thoſe minuteſt animals have all the joints, bones, muſcles, tendons, and nerves, neceſſary to that briſk and ſwift motion that many of them have, is ſo ſtupendious a piece of curious art (*l*), as plainly manifeſteth

(*l*) The minute curioſities, and inimitable fineries, obſervable in thoſe leſſer animals, in which our beſt microſcopes diſcover no botch, no rude ill-made work (contrary to what is in all artificial works of man) do they not far more deſerve our admiration, than thoſe celebrated pieces of human art? Such as the cup made of a pepper-corn, by *Oſwald Nerlinge*, that held 1200 ivory cups, all gilt on the edges, and having each of them a foot, and yet affording room for 400 more, in the *Epem. Germ. T.* 1. *Addend. ad Obſ.* 13. Such alſo was *Phaeton* in a ring, which *Galen* thus reflects upon, when he ſpeaks of the art and wiſdom of the maker of animals, particularly ſuch as are ſmall: ‘Quanto, ſaith he, ipſum minus fuerit, tanto majorem admirationem tibi excitabit; quod declarant opifices cum in corporibus parvis aliquid inſculpant: cujus generis eſt quòd nuper quidam in annulo Phaetonta quatuor equis invectum ſculpſit. Omnes enim equi frænum, os, & dentes anteriores habebant, &c. And then having taken notice, that the legs were no bigger than thoſe of a gnat, he ſhews, that their make did not come up to thoſe of the gnat; as alſo, ſaith he, ‘Major adhuc alia quædam eſſe videtur artis ejus, qui pulicem condidit, vis atque ſapientia, quod, &c. Cùm igitur ars tanta in tam abjectis animalibus appaniſeſteth the power and wiſdom of the infinite contriver of thoſe inimitable fineries. But having named thoſe minute animals, why ſhould I mention only any one part of their bodies, when we have in that little compaſs, a whole and complete body, as exquiſitely formed, and (as far as our ſcrutiny can poſſibly reach) as neatly adorned, as the largeſt animal? Let us conſider, that there we have eyes, a brain, a mouth, a ſtomach, entrails, and every other part of an animal body, as well as legs and feet; and that all thoſe parts have each of them their neceſſary apparatus of nerves, of various muſcles, and every other part that other inſects have; and that all is covered and guarded with a well-made tegument, beſet with briſtles, adorned with neat imbrications, and many other fineries. And laſtly, let us conſider in how little compaſs all art and curioſity may lie, even in a body many times leſs than a ſmall grain of ſand (*m*); ſo that the leaſt drop of water can contain many of

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'appareat,----quantam ejus vim ac ſapientiam in 'præſtantioribus ineſſe putabimus?' Galen. *de uſu part. l.* 17. *c.* 1. *fin.*

(*m*) It will in ſome meaſure appear, how wonderfully minute ſome microſcopical animalcules are, by what follows in the next note. But becauſe more particular examples would be endleſs, I ſhall refer to the obſervations of Mr. *Leuwenhoeck*, and others in the *Philoſ. Tranſact.* and elſewhere.

of them, and afforded them alſo ſufficient room to dance and friſk about in (*n*).

Having ſurveyed as many of the parts of inſects as I care to take notice of; I ſhall in the next place ſay ſomewhat of their ſtate, and circumſtances of life. And here I ſhall take notice only of two things, which have been only hinted at before; but will deſerve more particular conſideration here, as being acts of a wonderful inſtinct; namely, their ſecurity of themſelves againſt winter; and their ſpecial care of preſerving their ſpecies.

(*n*) It is almoſt impoſſible, by reaſon of their perpetual motion, and changing places, to count the number of the animalcules, in only a drop of the green ſcum upon water; but I gueſs I have ſometimes ſeen not fewer than 100 friſking about in a drop no bigger than a pin's head. But in ſuch a drop of pepper-water, a far greater number; theſe being much leſs than thoſe.

CHAP. V.

The Sagacity of Inſects *to ſecure themſelves againſt Winter.*

IT is an extraordinary act of inſtinct and ſagacity, obſervable in the generality of the inſect-tribe, that they all take care to ſecure themſelves, and provide againſt the neceſſities of winter: that when the diſtreſſes of cold and wet force them, they ſhould retire to warm and dry places of ſafety, is not ſtrange, but it is a prodigious act of the infinite conſervator's care, to enable ſome to live in a different kind of inſect-ſtate; others to live, as without action, ſo without food; and others that act and eat, to lay up in ſummer ſufficient proviſions againſt the approaching winter. Some, I ſay, live in a different ſtate; for having ſufficiently fed, nouriſhed, and bred up themſelves to the perfection of their Vermicular, Nympha-State, in the ſummer months, they then retire to places of ſafety, and there throw off their Nympha, and put on their Aurelia, or Chryſalis State, for all the winter, in which there are no occaſions for food. This is the conſtant method of many families of the inſect-tribe (*a*).

But

(*a*) It would be endleſs to enter into particulars here, becauſe all the Papilionaceous, Fleſh, and Ichneumon-fly tribes, and all others that undergo the Nympha and Aurelia ſtate, between that of the egg and the mature-ſtate (which are very numerous) appertain to this note. For a ſample therefore only, I ſhall take what ſome may think a mean one, but if conſidered, deſerves our admiration; and that is, the ſagacity of the white butter-fly Caterpillar, which having fed itſelf in due time, then retires to places of ſecurity. I have ſeen great trains of them creeping up the walls and poſts of the next houſes, where, with the help of ſome cobwebs like filaments, they hang themſelves to the ceilings, and other commodious places, and then become Aureliæ; in which

But there are others, and ſome of them in their moſt perfect ſtate too, that are able to ſubſiſt in a kind of torpitude, or ſleeping-ſtate, without any food at all; by reaſon as there is no action, ſo no waſte of body, no expence of ſpirits, and therefore no need of food (*b*).

But for others that move and act, and need food, it is a prodigious inſtinct and foreſight the Creator hath imprinted on them, to lay up ſufficient food in ſummer for the winter's

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which ſtate and places they hang ſecure from the wet and cold, till the ſpring, and warmer months, when they are tranſmuted into butter-flies.

(*b*) I ſhall not name any of the particular ſpecies of inſects which live in this ſtate, becauſe they are very numerous, but only remark two things obſervable in their ſagacity in this matter: 1. That they are not driven by ſtreſs of weather to their retirement, but ſeem as naturally to betake themſelves thereto, as other animals do to reſt and ſleep. For before the approach of cold weather, towards the end of ſummer, we may ſee ſome kinds of them flocking together in great numbers, within doors (as Swallows do a little before they leave us) as if they were making ready for their winter's reſt. 2. That every ſpecies betakes itſelf to a proper convenient receptacle; ſome under the waters to the bottoms of ponds, ſome under the earth, below the froſts; ſome under timber, ſtone, &c. lying on the ground; ſome into hollow trees, or under the bark, or in the wood; ſome into warm and dry places; and ſome into dry alone.

ter's (*c*) neceſſities and occaſions. And it is very pretty to ſee with what unwearied diligence all hands are at work for that purpoſe, all the warmer months. Of this the holy ſcripture itſelf gives us an inſtance in the Ant, calling that little animal 'exceeding wiſe,' *Prov.* xxx. 24. And the reaſon is, *ver.* 25. 'The Ants are a people not ſtrong, yet they 'prepare their meat in the ſummer.' And therefore Solomon ſends the ſluggard to this little contemptible creature, to learn wiſdom, foreſight, care, and diligence, *Prov.* vi. 6, 7, 8. 'Go to the ant, thou ſluggard, conſider 'her

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(*c*) There are not many kinds that thus provide their food before-hand. The moſt remarkable are the Ant and the Bee; concerning the firſt of which, *Origen* hath this remark; viz. 'De ſolertiâ formi'carum, venturæ hyemi maturè proſpicientium, 'ſibique invicem ſub onere feſſis ſuccurrentium; 'quódque fruges arroſas condunt, ut rurſus enaſ'cantur, ſed per annum alimento ſint, non ratio'cinationem formicarum in causâ debemus credere, 'ſed almam matrem naturam bruta quoque ſic or'nantem, ut etiam minimis addat ſua quædam in'genia.' Orig. *cont.* Cels. *l.* 4.

But as for Waſps, Hornets, Humble-bees, and other Wild-bees, Veſpæ Ichneumons, and divers others that carry in materials for neſts and food; this is only for the ſervice of their generation, for hatching their eggs, and nouriſhing their young, not for ſupplies in winter; for they all forſake their neſts towards winter, and retire to other quarters, living (I conceive) without food all that time.

'her ways, and be wiſe: which having no guide, overſeer, or ruler, provideth her meat in the ſummer, and gathereth her food in the harveſt.'

To this ſcriptural example, give me leave to anticipate, and ſubjoin an obſervation of the farther great wiſdom of this little creature; and that is their unparallelled Στοργὴ, their tenderneſs, ſagacity, and diligence, about their young (*d*). 'Tis very diverting, as well as

admirable

(*d*) 'Hos vermiculos [formicarum ova vulgò vocatos] incredibili Στοργῆ & curâ formicæ educant, ſummamque dant operam, ne vel tantillum, quod ſpectet eorum vermiculorum educationem atque nutritionem, omittant: quem in finem fere ſemper eoſdem ore circumportant ſecum, ne ulla eos lædat injuria. In muſeo meo nonnullas iſtius generis formicas, vitro terrâ repleto, concluſas cum vermiculis iſtis adſervabam: ibi non ſine jucunditate ſpectabam, quo terra fieret in ſuperficie ſiccior, eo profundiùs formicas cùm fœtibus ſuis prorepere: cùm verò aquam adfunderem, viſu mirificum erat, quanto affectu, quantâ ſolicitudine, quantà Στοργῆ omnem in eo collocarent operam, ut fœtus ſuos ſicciore & tuto loco reponenerent. Sæpiùs vidi, cùm aliquot diebus aquâ caruiſſent, atque cùm affuſo tantillo aquæ terram illam humectarem, è veſtigio à formicis fœtus ſuos eo loci fuiſſe allatos, quos ibi diſtinctè conſpiciebam moveri atque ſugere humorem. Multoties fui conatus, ut eos vermiculos ipſe educarem, at ſemper conatum fefellit eventus: neque

'ipſas

admirable to ſee, with what affection and care they carry about their young in their mouths, how they expoſe themſelves to the greateſt dangers, rather than leave their young expoſed or forſaken; how they remove them from place to place in their little hills, ſometimes to this part, ſometimes to that, for the benefit of convenient warmth, and proper moiſture; and then again withdraw, and guard them againſt rain and cold. Now that this great wiſdom which the ſcriptures attribute unto, and is diſcernible in this little animal, is owing only to the inſtinct, or infuſions of the great

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'ipſas formicarum nymphas alimenti jam non indigas unquam ſine ipſis formicis potui potu artificiali excludere.' J. Swammerd. *Epilog. ad hiſt. inſect. p.* 153.

Sir *Edward King*, who was very curious in examining the generation of Ants, obſerves their great care and diligence, 1. About their ſperm, or true eggs, which is a fine white ſubſtance, like ſugar, which they diligently gather together into a heap, when ſcattered, and on which they lie in multitudes (I ſuppoſe by way of Incubation.) 2. I have obſerved, ſaith he, in ſummer, that in the morning they bring up thoſe of their young (called Ant-eggs) towards the top of the bank: ſo that you may from 10 in the morning, until 5 or 6 afternoon, find them near the top------ for the moſt part on the ſouth-ſide the bank. But towards 7 or 8 at night, if it be cool, or likely to rain, you may dig a foot deep before you can find them. *Philoſ. Tranſ.* N° 23. or Mr. Lowthorp's *Abridg. vol.* II. *p.* 7, and 9.

great conſervator of the world, is evident, becauſe either this wiſdom, thought, and forecaſt, is an act of the animal itſelf, or of ſome other being that hath wiſdom, But the animal being irrational, 'tis impoſſible it can be its own act, but muſt be derived, or received from ſome wiſe being. And who, what can that be, but the infinite Lord, conſervator, and governor of the world?

CHAP. VI.

Of the Care of Inſects *about their Young.*

THE other notable inſtinct I am to treat of, is the peculiar art and care of the inſect-tribe, about the preſervation of their ſpecies. Here I might ſpeak of many things, but I have occaſionally mentioned divers of them before, under ſome or other of the general heads, and therefore ſhall fix only upon two things relating to their ſpecial art and care about the production (*a*) of their young, which have not been ſo particularly ſpoken to as they deſerve.

One

(*a*) The doctrine of æquivocal generation is at this day ſo ſufficiently exploded by all learned philoſophers, that I ſhall not enter the diſpute, but take it for granted, that all animals ſpring from other parent-animals. If the reader hath any doubt about it, I refer him to Seigneur Redi *de gen. inſect.* and Mr. Ray's *Wiſdom of God*, &c. *p.* 344. See alſo before, *book* iv. *chap.* 15. *note* (*a*).

One thing is, their ſingular providence for their young, in making or finding out ſuch proper receptacles and places for their eggs and ſeed, as that they may receive the advantage of a ſufficient incubation, and that the young, when produced, may have the benefit of proper and ſufficient food for their nurture and education, till they are able to ſhift for themſelves. It is admirable to ſee with what diligence and care the ſeveral ſpecies of inſects lay up their eggs, or ſperm, in their ſeveral proper places; not all in the waters, in wood, or on vegetables, but thoſe whoſe ſubſiſtence is in the waters (*b*), in the water; thoſe to whom fleſh is a proper food, in fleſh (*c*); thoſe to whom the fruits

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(*b*) It would be endleſs to ſpecify the various ſpecies of inſects, that have their generation in the waters: And therefore I ſhall only obſerve of them, 1. That their eggs are always laid up with great care, and in good order. And alſo, 2. Where proper and ſufficient food is. 3. That in their Nympha-ſtate in the waters, they have parts proper for food and motion; and in many or moſt of them, very different from what they have in their mature-ſtate; a manifeſt argument of the Creator's wiſdom and providence. For an inſtance, ſee *note* (*r*).

(*c*) As Seigneur *Redi* was one of the firſt that made it his buſineſs to diſcard anomalous generation, ſo he tried more experiments relating to the vermination of ſerpents, fleſh, fiſh, putrified vegetables; and, in ſhort, whatever was commonly known

known to be the nurſery of maggots, more, I ſay, probably, than any one hath done ſince. And in all his obſervations, he conſtantly found the maggots, to turn to Aureliæ, and theſe into flies. But then, ſaith he, 'Dubitare cœpi, utrùm omne hoc 'vermium in carne genus, ex ſolo muſcarum ſe'mine, an ex ipſis putrefactis carnibus oriretur, 'tantoque magis confirmabar in hoc meo dubio, 'quanto in omnibus generationibus-------- ſæpiùs 'videram, in carnibus, antequam verminare inci'perent, reſediſſe ejuſdem ſpeciei muſcas, cujus 'propago poſtea naſcebatur.' Upon this he tells us, he put fiſh, fleſh, &c. into pots, which he covered cloſe from the flies with paper, and afterwards (for the free air-ſake) with lawn, whilſt other pots were left open, with ſuch-like fleſh, &c. in them; that the flies were very eager to get into the covered pots; and that they produced not one maggot, when the open ones had many. Fr. Redi *de gener. inſect.*

Among the inſects that come from the maggots he mentions, he names Culices. Now from the moſt critical obſervations I have made, I never obſerved any ſort of Gnat to come from putrified fleſh, vegetables, or any other thing he taxeth them with. So that either he means by Culex, ſome fly that we call not by the name of Gnat; or elſe their Gnats in *Italy* vary in their generation from ours in *England.* For among above thirty, near forty, diſtinct ſpecies of Gnats that I have obſerved about the place where I live, I never found any to lay their eggs in fleſh, fiſh, &c. but the largeſt ſort, called by *Aldrovand*, Culices maximi, by *Swammerdam*, Tipulæ terreſtres; lay their eggs in meadows, &c. under the graſs; one of the larger middle ſort, in dead-beer, yeaſt, &c. lying on the tops, or in fruits (*d*) or leaves of vegetables are food, are accordingly

the leaks of beer-barrels, &c. and all the reſt (as far as ever I have obſerved) lay and hatch in the waters, as in *note* (*r*).

The generation of the ſecond of theſe being akin to ſome of the foregoing inſtances, and a little out of the way, may deſerve a place here. This Gnat lays its eggs commonly in dead beer, &c. as I ſaid, and probably in vinegar, and other ſuch liquors. Some time after which, the maggots are ſo numerous, that the whole liquor ſtirreth as if it was alive; being full of maggots, ſome larger, ſome ſmaller; the larger are the offspring of our Gnats, the ſmaller, of a ſmall dark-coloured fly, tending to reddiſh, frequent in cellars, and ſuch obſcure places. All theſe maggots turn to Aureliæ; the larger of which, of a tan-colour, turn to our Gnat. This Gnat is of the unarmed kind, having no ſpear in its mouth: Its head is larger than of the common gnats, a longer neck, ſhort-jointed Antennæ, ſpotted wings, reaching beyond its ſlender Alvus; it is throughout of a brown colour; tending to red, eſpecially in the female: The chief difference between the male and female is (as in other gnats, yea, moſt inſects) the male is leſs than the female, and hath a ſlenderer belly, and its Podex not ſo ſharp as the female's is.

(*d*) The inſects that infeſt fruits, are either of the Ichneumon-fly kind, or Phalænæ. Plumbs, peaſe, nuts, &c. produce ſome or other Ichneumon-fly. That generated in the plumb is black, of a middle ſize, its body near three-tenths of an inch long, its tail not much leſs, conſiſting of three briſtles, wherewith it conveys its eggs into fruits: Its are accordingly repoſited, ſome in this fruit, ſome on this tree (*e*), ſome on that plant,

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Its Antennæ, or horns, long, ſlender, recurved; its belly longiſh, tapering, ſmall towards the Thorax; legs reddiſh; wings membranaceous, thin, and tranſparent, in N° 4. which is one characteriſtick of the Ichneumon-fly.

The Peaſe Ichneumon-fly is very ſmall, wings large, reaching beyond the Podex; Antennæ long; Alvus ſhort, ſhaped like an heart, with the point towards the Anus; it walketh and flieth ſlowly: No tail appears as in the former; but they have one lieth hidden under the belly, which they can at pleaſure bend back to pierce peaſe when they are young and tender, and other things alſo, as I have reaſon to ſuſpect, having met with this (as indeed the former two) in divers vegetables.

Pears and Apples I could never diſcover any thing to breed in, but only the leſſer Phalæna, about four tenths of an inch long, whitiſh underneath, greyiſh brown above (dappled with brown ſpots, inclining to a dirty red) all but about a third part at the end of the wings, which is not grey, but brown, elegantly ſtriped with wavey lines, of a gold colour, as if gilt; its head is ſmall, with a tuft of whitiſh brown in the forehead; Antennæ ſmooth, moderately long. The Aurelia of this moth is ſmall, of a yellowiſh brown. I know not what time they require for their generation out of boxes; but thoſe I laid up in *Auguſt*, did not become moths before *June* following.

(*e*) There are many of the Phalænæ and Ichneumon-fly tribes, that have their generation on the leaves, or other parts of trees and ſhrubs, too many to plant (*f*), ſome on another, and another; but conſtantly the ſame family on the ſame tree or plant, the moſt agreeable to that family. And as for others that require a conſtant and greater degree of warmth, they are accordingly provided by the parent-animal with ſome place in or about the body of other animals;

to be here reckoned up. The Oak hath many very beautiful Phalænæ, bred in its convolved leaves, white, green, yellow, brown, ſpotted prettily, and neatly dappled, and many more beſides; and its buds afford a place for caſes, and balls of various ſorts, as ſhall be ſhewn hereafter; its leaves expanded, miniſter to the germination of globular, and other ſphæroidical balls, and flat Thecæ, ſome like hats, ſome like buttons excavated in the middle; and divers other ſuch-like repoſitories, all belonging to the Ichneumon-fly kind. And not only the Oak, but the Maple alſo, the White-thorn, the Brier, Privet, and indeed almoſt every tree and ſhrub.

(*f*) And as trees and ſhrubs, ſo plants have their peculiar inſects. The white Butter-fly lays its voracious offspring on cabbage-leaves; a very beautiful reddiſh ocellated one; its no leſs voracious black offspring, of an horrid aſpect, on the leaves of nettles; as alſo doth a very beautiful, ſmall, greeniſh Ichneumon-fly, in caſes on the leaves of the ſame plant: And to name no more (becauſe it would be endleſs) the beautiful Ragwcrth Moth, whoſe upper wings are brown, elegantly ſpotted with red, and under wings edged with brown; theſe, I ſay, provide for their golden-ring'd Erucæ upon the Ragwort-plant.

animals; ſome in the feathers of birds (*g*): ſome in the hair of beaſts (*b*); ſome in the very

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(*g*) Many, if not moſt ſorts of birds, are infeſted with a diſtinct kind of lice, very different from one another in ſhape, ſize, &c. For figures and deſcriptions of them, I ſhall refer to Seigneur Redi *of inſects*. See alſo Moufet, *l.* 2. *c.* 23. Theſe lice lay their nits among the feathers of the reſpective birds, where they are hatched and nouriſhed; and, as Ariſtotle ſaith, would deſtroy the birds, particularly Pheaſants, if they did not duſt their feathers. *Loco infra citat.*

(*b*) And as birds, ſo the ſeveral ſorts of beaſts have their peculiar ſorts of lice; all diſtinct from the two ſorts infeſting man: Only the Aſs, they ſay, is free, becauſe our Saviour rode upon one, as ſome think; but I preſume it is rather from the paſſage in Pliny, *l.* 11. *c.* 33. or rather Ariſt. *Hiſt. animal. l.* 3. *c.* 31. who ſaith, 'Quibus pilus eſt, 'non carent eodem [Pediculo] excepto Aſino, qui 'non Pediculo tantùm, verùm etiam redivio immunis eſt.' And a little before, ſpeaking of thoſe in men, he ſhews what conſtitutions are moſt ſubject to them, and inſtanceth in Alcman the poet, and Pherecydes Syrius, that died of the Pthiriaſis, or louſy diſeaſe. For which foul diſtemper, if medicines are deſired, Moufet *de inſect. p.* 262. may be conſulted; who in the ſame page hath this obſervation: 'Animadverterunt noſtrates-----ubi 'aſores inſulas à tergo reliquerint, pediculos confeſtim omnes tabeſcere: atque ubi eas reviſerint, 'iterum innumeros alios ſubitò oriri.' Which obſervation is confirmed by Dr. Stubs. Vide Lowth. *Abridg. vol.* III. *p.* 558. And many ſeamen have told me the ſame.

very ſcales of fiſhes (*i*); ſome in the noſe (*k*); ſome in the fleſh (*l*); yea, ſome in the very bowels

(*i*) Fiſhes, one would think, ſhould be free from lice, by reaſon they live in the waters, and are perpetually moving in, and bruſhing through them; but yet they have their ſorts too.

Beſides which I have frequently found great numbers of long ſlender worms in the ſtomachs, and other parts of fiſh, particularly Codfiſh, eſpecially ſuch as are poor; which worms have work'd themſelves deeply into the coats and fleſh, ſo that they could not eaſily be gotten out: So Ariſtotle ſaith of ſome fiſhes, 'Ballero & tilloni lumbricus 'inaſcitur, qui debilitat, &c. Chalcis vitio infeſta- 'tur diro, ut pediculi ſub branchiis innati quàm 'multi interimant.' *Hiſt. an. l.* 8. *c.* 20.

(*k*) Of inſects bred in the noſe of animals, thoſe in the noſtrils of ſheep are remarkable. I have myſelf taken out not fewer at a time than twenty or thirty rough maggots, lying among the Laminæ of the noſtrils. But I could never hatch any of them, and ſo know not what animal they proceed from: But I have no great doubt, they are of the Ichneumon-fly kind, and not improbably of that with a long tail, call'd Triſeta, whoſe three briſtles ſeem very commodious for conveying its eggs into deep places.

I have alſo ſeen a rough whitiſh maggot, above two inches within the Inteſtinum rectum of horſes, firmly adhering thereto, that the hard dung did not rub off. I never could bring them to perfection, but ſuſpect the Side-fly proceeds from it.

(*l*) In the backs of Cows, in the ſummer-months, there are maggots generated, which in Eſſex we call

call Wornils; which are firſt only a ſmall knot in the ſkin; and, I ſuppoſe, no other than an egg laid there by ſome inſect. By degrees theſe knots grow bigger, and contain in them a maggot lying in a purulent matter: They grow to be as large as the end of one's finger, and may be ſqueez'd out at a hole they have always open. They are round and rough, and of a dirty white. With my utmoſt endeavour and vigilance, I could never diſcover the animal they turn into; but as they are ſomewhat like, ſo may be the ſame as thoſe in the note before.

In Perſia there are very long ſlender worms bred in the legs, and other parts of men's bodies, 6 or 7 yards long.

In *Philoſ. Tranſ.* Mr. Dent, and Mr. Lewis, relate divers examples of worms taken out of the tongue, gums, noſe and other parts, by a woman at Leiceſter, which they were eye-witneſſes of. Theſe and divers others mentioned in the *Tranſactions*, may be ſeen together in Mr. Lowthorp's *Abridg. vol.* III. *p.* 132.

'Narrat mihi vir fide dignus------Caſp. Wend'landt---ſe in Poloniâ, puero cuidam ruſtico duo'rum annorum, vermiculum album è palpebrâ ex'traxiſſe,----magnitudinis Erucæ.----Similem fere 'huic caſum mihi [Schulzio] & D. Segero narravit 'hoc anno 1676, chirurgus noſter Ant. Statlender, 'qui cuidam puero, ex aure, extraxit vermiculum 'talem, qualis in nucibus avellanis perforatis lati'tare ſolet, ſed paulò majorem, coloris albiſſimi; 'alteri minores 5 ejuſdem generis ſimiliter ex aure: 'Omnes aliquot horas ſupervixerunt----Vermicu'los adhuc viventes oculis noſtris vidimus.' *Ephem. Germ. T.* 2. *Obſ.* 24. *ubi Vermiculi Icon.* Many other inſtances may be met with in the ſame Tome, *Obſ.* 147, 148, 154.

bowels (*m*), and inmoſt receſſes of the bodies of

The worms in Deer are mentioned often among ancient writers. Ariſtotle ſaith, Σκώληκας μέντοι πάντες ἔχουσιν, ἐν τῇ κεφαλῇ ζῶντας, &c. ‘ They ‘ [Deer] all have live worms in their heads, bred ‘ under the tongue, in a cavity near the vertebra ‘ on which the head is placed ; their ſize not leſs ‘ than of the largeſt maggots ; they are bred all to‘ gether, in number about twenty.’ Ariſtot. *Hiſt. animal. l.* 2. *c.* 15.

To theſe examples may be added the generation of the Ichneumon-fly in the bodies of caterpillars, and other nymphæ of inſects. In many of which, that I have laid up to be hatch'd in boxes, inſtead of Papilios, &c. as I expected, I have found a great number of ſmall Ichneumon-flies, whoſe parent-animal had wounded thoſe nymphæ, and darted its eggs into them, and ſo made them the foſter-mother of its young. More particulars of this way of generation may be ſeen in the great Mr. Willughby's obſervations in *Philoſ. Tranſ.* N° 76. But concerning the farther generation of this inſect, I have taken notice of other particulars in other places of theſe notes.

(*m*) The animals ordinarily bred in the ſtomach and guts, are the three ſorts of worms call'd Lati, Teretes, and Aſcarides ; concerning which, it would be irkſom to ſpeak in particular, and therefore I ſhall refer to Moufet, *l.* 2. *c.* 31, 32, 33. Dr. Tyſon's anatomy of them in Mr. Lowthorp's *Abridg. vol.* III. *p.* 121. Seigneur Redi's *Obſ.* and others that have written of them.

And not only worms, but other creatures alſo, are ſaid to be found in the ſtomach ; inſtances of which are ſo innumerable, that I ſhall only ſelect a few

few related by perſons of the beſt credit. And firſt of all, by ſome of our own countrymen. Dr. Liſter (whoſe credit and judgment will hardly be queſtion'd) gives an account of true Caterpillars, vomited up by a boy of nine years old; and another odd animal by a poor man. Mr. Jeſſop (another very judicious, curious, and ingenious gentleman) ſaw Hexapods vomited up by a girl; which Hexapods lived and fed for five weeks. *See* Lowth. *ib. p.* 135.

As to foreigners, it is a very ſtrange ſtory (but atteſted by perſons of great repute) of Catharina Geileria, that died in Feb. 1662, in the hoſpital of Altenburg, in Germany, who for twenty years voided by vomit and ſtool Toads and Lizzards, &c. *Ephemer. Germ. T.* 1. *Obſ.* 103. See alſo the 109th Obſervation of a Kitten bred in the ſtomach, and vomited up; of Whelps alſo, and other animals, bred in like manner. But I fear a ſtretch of fancy might help in ſome of thoſe laſt inſtances, in thoſe days when ſpontaneous generation was held, when the philoſophers ſeem to have more ſlightly examined ſuch appearances than now they do. But for the breeding of Frogs or Toads, or Lacertæ Aquaticæ, in the ſtomach, when their ſpawn happeneth to be drank, there is a ſtory in the ſecond Tome of the *Ephem. Germ. Obſ.* 56. that favours it; viz. ' In the year 1667, a butcher's man going to ' buy ſome lambs in the ſpring, being thirſty, ' drank greedily of ſome ſtanding water, which a ' while after cauſed great pains in his ſtomach, ' which grew worſe and worſe, and ended in dan' gerous ſymptoms. At laſt he thought ſomewhat ' was alive in his ſtomach, and after that, vomited ' up three live Toads, and ſo recover'd his former ' health.'

bodies of man and other creatures (*n*): And as for others, to whom none of theſe methods are proper, but make themſelves neſts by perforations in the earth, in wood, or combs they build, or ſuch like ways; 'tis admirable to ſee with what labour and care they carry in, and

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Such another ſtory Dr. Sorbait tells, and avoucheth it ſeen with his own eyes, of one that had a Toad came out of an abſceſs, which came upon drinking foul water. *Obſ.* 103.

(*n*) Not only in the guts, and in the fleſh, but in many other parts of the body, worms have been diſcover'd. One was voided by urine, by Mr. Mat. Milford, ſuppoſed to have come from the kidneys. Lowth. *ib. p.* 135. More ſuch examples Mouſet tells of, *ibid.* So the Vermes Cucurbitini are very common in the veſſels in Sheeps livers: And Dr. Liſter tells of them, found in the kidney of a Dog, and thinks that the Snakes and Toads, &c. ſaid to be found in animals bodies, may be nothing elſe. Lowth. *ib. p.* 120. Nay, more than all this, in Dr. Bern. Verzaſcha's ſixth obſervation, there are divers inſtances of worms bred in the brain of man. One, a patient of his, troubled with a violent head-ach, and an itching about the noſtrils, and frequent ſneezing; who, with the uſe of a ſneezing powder, voided a worm, with a great deal of ſnot from his noſe. A like inſtance he gives from Bartholine, of a worm voided from the noſe of O. W. which he gueſſeth was the famous Olaus Wormius: Another, from a country-woman of Deitmarſh; and others in Tulpius, F. Hildanus, Schenckius, &c. Theſe worms he thinks are undoubtedly bred in the brain; but what way they can and ſeal up proviſions, that ſerve both for the production of their young, as alſo for their food and nurture when produced (*o*).

The other piece of remarkable art and care about the production of their young, is their curioſity

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can come from thence I can't tell. Wherefore I rather think, they are ſuch worms as are mention'd in note (*k*), and even that worm that was actually found in the brain of the Paris girl (when opened) I gueſs might be laid in the Laminæ of the noſtrils, by ſome of the Ichneumon, or other inſect-kind, and might gnaw its way into the brain, through the Os Cribriforme. Of this he tells us from Bartholine, 'Tandem cum tabida obiiſſet, ſtatim aperto cranio præſentes medici totam cerebelli ſubſtantiam, quæ ad dexterum vergit, à reliquo corpore ſejunctam, nigrâque tunicâ involutam deprehenderunt: hæc tunica rupta, latentem vermem vivum, & piloſum, duobus punctis ſplendidis loco oculorum prodidit, ejuſdem fere molis cum reliquâ Cerebri portione, qui duarum horarum ſpatio ſupervixit.' B. Verzas *Obſ. Medicæ*, *p.* 16.

Hildanus tells us ſuch another ſtory; viz. 'Filius Theod. auſt der Roulen, avunculi mei, diuturno vexabatur dolore capitis.----Deinde febriculâ & ſternutatione exortâ, ruptus eſt abſceſſus circa os cribroſum----& vermis prorepſit.' By his figure of it, the maggot was an inch long, and full of briſtles. Fabri Hildan. *Cent.* 1. *Obſ.*

Galenus Wierus (phyſician to the Princ. Jul. & Cleve) he ſaith, told him, that he had, at divers times, found worms in the gall-bladder in perſons he had opened at Duſſeldorp. *id. ib. Obſ.* 60.

(*o*) See before, *book* iv. *chap.* 13. *note* (*c*) curioſity and neatneſs in repoſiting their eggs, and in their nidification.

As to the firſt of which we may obſerve, that great curioſity and nice order is generally obſerved by them in this matter. You ſhall always ſee their eggs laid carefully and commodiouſly up (*p*). When upon the leaves of vegetables, or other materials on land, always glued thereon with care, with one certain end lowermoſt, and with handſome juxta-poſitions (*q*). Or if in the waters, in neat and beautiful rows, oftentimes in that ſpermatick, gelatine matter, in which they are repoſited, and that matter carefully tied and faſten'd in the waters, to prevent its diſſipation (*r*), or if

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(*p*) Some inſects lay up their eggs in cluſters, as in holes of fleſh, and ſuch places, where it is neceſſary they ſhould be crouded together; which, no queſtion, prevents their being too much dried up in dry places, and promotes their hatching. But,

(*q*) As for ſuch as are not to be cluſtered up, great order is uſed. I have ſeen upon the poſts and ſides of windows, little round eggs, reſembling ſmall pearl, which produced ſmall hairy Caterpillars, that were very neatly and orderly laid. And, to name no more, the white Butterfly lays its neat eggs on the cabbage-leaves in good order, always gluing one certain end of the egg to the leaf. I call them neat eggs, becauſe if we view them in a microſcope, we ſhall find them very curiouſly furrowed, and handſomly made and adorned.

(*r*) By reaſon it would be endleſs to ſpecify the various generation of inſects in the water, I ſhall therefore if made to float, ſo carefully ſpread and poiſed, as to ſwim about with all poſſible artifice.

And therefore (becauſe it is little obſerved) take Pliny's inſtance of the Gnat, a mean and contemned animal, but a notable inſtance of Nature's work, as he ſaith.

The firſt thing conſiderable in the generation of this inſect is (for the ſize of the animal) its vaſt ſpawn, being ſome of them above an inch long, and half a quarter diameter; made to float in the water, and tied to ſome ſtick, ſtone, or other fixed thing in the waters, by a ſmall ſtem, or ſtalk. In this gelatine, tranſparent ſpawn, the eggs are neatly laid; in ſome ſpawns in a ſingle, in ſome in a double ſpiral line, running round from end to end, as in *fig.* 9, and 10. and in ſome tranſverſly, as in *fig.* 8.

When the eggs are by the heat of the ſun, and warmth of the ſeaſon, hatched into ſmall maggots, theſe maggots deſcend to the bottom, and by means of ſome of the gelatine matter of the ſpawn (which they take along with them) they ſtick to ſtones, and other bodies, at the bottom, and there make themſelves little caſes or cells, which they creep into and out of at pleaſure, until they are arrived to a more mature Nympha-ſtate, and can ſwim about here and there, to ſeek for what food they have occaſion; at which time, they are a kind of red worms, above half an inch long, as in *fig.* 11.

Thus far this mean inſect is a good inſtance of the Divine Providence towards it. But if we farther conſider, and compare the three ſtates it undergoes after it is hatched, we ſhall find yet greater ſignals of the Creator's management, even in theſe meaneſt

And as to their other faculty, that of nidification, whether it be exerted by boring the earth or wood, or building themſelves cells (*s*), or ſpinning and weaving themſelves caſes and webs, it is all a wonderful faculty of thoſe meaneſt of creatures. The three ſtates I mean, are its Nympha-vermicular ſtate, its Aurelia, and Mature ſtate, all as different, as to ſhape and accoutrements, as if the inſect was three different animals. In its Vermicular ſtate, it is a red maggot, as I ſaid, and hath a mouth and other parts accommodated to food: In its Aurelia ſtate, it hath no ſuch parts, becauſe it then ſubſiſts without food; but in its Mature, Gnat ſtate, it hath a curious well-made ſpear, to wound and ſuck the blood of other animals. In its Vermicular ſtate, it hath a long worm-like body, and ſomething analogous to fins or feathers, ſtanding erect near its tail, and running parallel with the body; by means of which reſiſting the waters, it is enabled to ſwim about by curvations, or flapping its body ſideways, this way and that, as in *fig.* 12.

But in its Aurelia ſtate it hath a quite different body, with a club-head (in which the head, thorax, and wings of the Gnat are incloſed) a ſlender alvus, and a neat finny tail, ſtanding at right angles with the body, quite contrary to what it was before; by which means, inſtead of eaſy flapping ſideways, it ſwims by rapid, briſk jirks, the quite contrary way; as is in ſome meaſure repreſented in *fig.* 13. But when it becomes a Gnat, no finny tail, no club-head, but all is made in the moſt accurate manner for flight and motion in the air, as before it was for the waters.

(*s*) See *book* iv. *chap.* 13. *notes* (*n*) (*o*).

thoſe poor little animals, whether we conſider their parts wherewith they work, or their work itſelf. Thus thoſe who perforate the earth, wood, or ſuch like, they have their legs, feet, mouth, yea, and whole body accommodated to that ſervice: their mouth exactly formed to gnaw thoſe handſom round holes, their feet as well made to ſcratch and bore (*t*), and their body handſomly turned and fitted to follow. But for ſuch as build or ſpin themſelves neſts, their art juſtly bids defiance to the moſt ingenious artiſt among men, ſo much as tolerably to copy the nice geometrical combs of ſome (*u*), the earthen cells of others, or the webs, nets, and caſes (*w*) woven

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(*t*) Thus the mouths and other parts of the Ichneumon-waſps in *book* iv. *chap.* 13. *note* (*e*). So the feet of the Gryllotalpa, *ibid. note* (*s*).

(*u*) See the laſt cited places, *note* (*o*).

(*w*) Of the textrine art of the Spider, and its parts ſerving to that purpoſe, ſee the laſt cited place, *note* (*x*).

Beſides theſe, Caterpillars, and divers other inſects, can emit threads or webs, for their uſe. In this their Nympha ſtate, they ſecure themſelves from falling, and let themſelves down from the boughs of trees, and other high places, with one of theſe threads. And in the caſes they weave, they ſecure themſelves in their Aurelia ſtate.

And not only the offspring of the Phalæna tribe, but there are ſome of the Ichneumon-fly kind alſo, endowed with this textrine art. Of theſe I have met with two ſorts; one that ſpun a milk-white, long, woven by others. And here that natural glue (*x*) which their bodies afford ſome of them,

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long, round, ſilken-web, as big as the top of one's finger, not hollow within, as many are, but filled throughout with ſilk. Theſe are woven round bents, ſtalks of Ribwort, &c. in meadows. The other is a lump of many yellow, ſilken caſes, ſticking confuſedly together on poſts, under Coleworts, &c. Theſe webs contain in them ſmall, whitiſh maggots; which turn to a ſmall, black Ichneumon-fly, with long, capillary Antennæ; tan-coloured legs; long wings reaching beyond their body, with a black ſpot near the middle; the Alvus like an heart; and in ſome, a ſmall ſetaceous tail. Some of theſe flies were of a ſhining, beautiful green colour. I could not perceive any difference, at leaſt not ſpecifical, between the flies coming from thoſe two productions.

(*x*) I have often admired how Waſps, Hornets, Ichneumon-waſps, and other inſects that gather dry materials for building their neſts, have found a proper matter to cement and glue their combs, and line their cells; which we find always ſufficiently context and firm. But in all probability, this uſeful material is in their own bodies; as 'tis in the Tinea Veſtivora, the Cadew-worm, and divers others. Goedart obſerves of his Eruca, *Numb.* xx. 6. that fed upon Sallow-leaves, that it made its cell of the comminuted leaves, glued together with its own ſpittle, 'Hæc pulveris aut arenæ inſtar comminuit, ac pituitoſo quodam ſui corporis ſucco ita maceravit, ut inde accommodatum ſubeundæ mutationi inſtanti locum ſibi exſtruxerit. Domuncula hæc à communi ſalicum ligno nihil differre videbatur, niſi quòd longè eſſet durior, adeò ut cultro vix diſrumpi poſſet.'

them, to conſolidate their work, and combine its materials together, and which in others can be darted out at pleaſure, and ſpun and woven by them into ſilken balls (*y*) or webs: I ſay, this ſo peculiar, ſo ſerviceable a material, together with the curious ſtructure of all parts miniſtring to this textrine power, as mean a buſineſs as it may ſeem, is ſuch as may juſtly be accounted among the noble deſigns and works of the infinite Creator and conſervator of the world.

In the laſt place, there is another prodigious faculty, art, cunning, or what ſhall I call it? that others of thoſe little animals have, to make even nature itſelf ſerviceable to their purpoſe; and that is, the making the vegetation and growth of trees and plants, the very means of the building of their little neſts and cells (*z*), ſuch as are the galls and balls found

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(*y*) 'An ingenious gentlewoman of my acquaintance, wife to a learned phyſician, taking 'much pleaſure to keep ſilk-worms, had once the 'curioſity to draw out one of the oval caſes which 'the ſilk-worm ſpins-----into all the ſilken wire it 'was made up of, which, to the great wonder as 'well of her huſband as herſelf,---appeared to be, 'by meaſure, a great deal above 300 yards, and 'yet weighed but two grains and an half.' Boyle, *Subtil. of Effluv. ch.* 2.

(*z*) Since my penning this, I have met with the moſt ſagacious Malpighi's account of Galls, &c. and find his deſcriptions to be exceedingly accurate and true, having traced myſelf many of the productions ſound on the leaves and branches of divers

ductions he hath mentioned. But I find Italy and Sicily (his book *de Gallis* being publiſhed long after he was made profeſſor at Meſſina) more luxuriant in ſuch productions than England, at leaſt than the parts about Upminſter (where I live) are. For many, if not moſt of thoſe about us, are taken notice of by him, and ſeveral others beſides that I never met with; although I have for many years as critically obſerved all the excreſcences, and other morbid tumors of vegetables, as is almoſt poſſible, and do believe that few of them have eſcaped me.

As to the method how thoſe Galls and Balls are produced, the moſt ſimple, and conſequently the moſt eaſy to be accounted for, is that in the gems of oak, which may be called Squamous Oak-cones, Capitula Squamata, in Malpighi: Whoſe deſcription not exactly anſwering our Engliſh cones in divers reſpects, I ſhall therefore paſs his by, and ſhew only what I have obſerved myſelf concerning them.

Theſe Cones are, in outward appearance, perfectly like the gems, only vaſtly bigger; and indeed they are no other than the gems, increaſed in bigneſs, which naturally ought to be puſhed out in length: The cauſe of which obſtruction of the vegetation is this: Into the very heart of the young tender gem or bud (which begins to be turgid in June, and to ſhoot towards the latter end of that month, or beginning of the next; into this, I ſay) the parent-inſect thruſts one or more eggs, and not perhaps without ſome venomous ichor therewith. This egg ſoon becomes a maggot, which eats itſelf a little cell in the very heart or pith of the gem, which is the rudiment of the branch, tovers vegetables, ſuch as the oak, the willow (*aa*), the briar, and ſome others.

Now

gether with its leaves and fruit, as ſhall be hereafter ſhewn. The branch being thus wholly deſtroyed, or at leaſt its vegetation being obſtructed, the ſap that was to nouriſh it, is diverted to the remaining parts of the bud, which are only the ſcaly teguments; which, by theſe means, grow large and flouriſhing, and become a covering to the inſect caſe, as before they were to the tender branch and its appendage.

The Caſe lying within this cone, is at firſt but ſmall, as the maggot included in it is, but by degrees, as the maggot increaſeth, ſo it grows bigger, to about the ſize of a large white peaſe, long and round, reſembling the ſhape of a ſmall Acorn.

The Inſect itſelf is (according to the modern inſectologers) of the Ichneumon-fly kind; with four membranaceous wings, reaching a little beyond the body, articulated horns, a large thorax, bigger than the belly; the belly ſhort and conical, much like the heart of animals; the legs partly whitiſh, partly black. The length of the body from head to tail, about $\frac{2}{10}$ of an inch; its colour a very beautiful ſhining green, in ſome tending to a dark copper-colour. Figures both of the Cones, Caſes, and Inſects, may be ſeen among Malpighi's cuts of Galls, *tab.* 13. and *tab.* 20. *fig.* 72. which *fig.* 72. exhibits well enough ſome others of the Gall-inſects, but its thorax is ſomewhat too ſhort for ours.

(*aa*) Not only the Willow, and ſome other trees, but plants alſo, as Nettles, Ground-ivy, &c. have caſes produced on their leaves, by the injection of

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Now this is ſo peculiar an artifice, and ſo far out of the reach of any mortal underſtanding, wit, or power, that if we conſider the matter, with ſome of its circumſtances, we muſt needs perceive manifeſt deſign, and that there is the concurrence of ſome great and wiſe being, that hath, from the beginning, taken care of, and provided for the animal's good: For which reaſon, as mean as the inſtance may ſeem, I might be excuſed, if I ſhould enlarge upon its particulars. But two or three hints ſhall ſuffice.

In the firſt place, 'tis certain that the formation of thoſe caſes and balls quite exceeds the cunning of the animal itſelf; but it is the

act

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the eggs of an Ichneumon-fly. I have obſerved thoſe caſes always to grow in, or adjoining to ſome rib of the leaf, and their production I conceive to be thus; viz. The parent-inſect, with its ſtiff ſetaceous tail, terebrates the rib of the leaf, when tender, and makes way for its egg into the very pith or heart thereof, and probably lays in therewith ſome proper juice of its body, to pervert the regular vegetation of it. From this wound ariſes a ſmall excreſcence, which (when the egg is hatched into a maggot) grows bigger and bigger, as the maggot increaſes, ſwelling on each ſide the leaf between the two membranes, and extending itſelf into the parenchymous part thereof, until it is grown as big as two grains of wheat. In this caſe lies a ſmall, white, rough maggot, which turns to an Aurelia, and afterwards to a very beautiful, green, ſmall Ichneumon-fly.

act partly of the vegetable, and partly of ſome virulency (or what ſhall I call it?) in the juice, or egg, or both, repoſited on the vegetable by the parent animal (*bb*). And as this virulency

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(*bb*) What I ſuſpected myſelf, I find confirmed by Malpighi, who in his exact and true deſcription of the fly bred in the Oaken Galls, ſaith, ‘Non ſat fuit naturæ tam miro artificio terebram ſeu Limam condidiſſe; ſed inflicto vulnere, vel excitato foramine infundendum exinde liquorem intra terebram condidit: quare fractâ per tranſverſam muſcarum terebrâ frequentiſſimè, vivente animali, guttæ aliquot diaphani humoris effluunt.’ And a little after, he confirms, by ocular obſervation, what he imagined before; viz. ‘Semel prope Junii finem vidi muſcam, qualem ſuperiùs delineavi, inſidentem quercinæ gemmæ, adhùc germinanti; hærebat etenim foliolo ſtabili ab apice hiantis gemmæ erumpenti; & convulſo in arcum corpore, terebram evaginabat, ipſamque tenſam immittebat; & tumefacto ventre circa terebræ radicem tumorem excitabat, quem interpolatis vicibus remittebat. In folio igitur, avulſâ Muſcâ, minima & diáphana reperi ejecta ova, ſimillima iis, quæ adhuc in tubis ſupererant. Non licuit iterum idem admirari ſpectaculum, &c.’

Something like this, which Malpighi ſaw, I had the good fortune to ſee myſelf once, ſome years ago: And that was, the beautiful ſhining Oak-ball Ichneumon ſtrike its terebra into an Oak-apple divers times, no doubt to lay its eggs therein. And hence I apprehend we ſee many Vermicules towards the outſide of many of the Oak-apples, which I gueſs virulency is various, according to the difference of its animal, ſo is the form and texture of the caſes and balls excited thereby; ſome being hard ſhells (*cc*), ſome tender balls (*dd*), ſome

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gueſs were not what the primitive inſects laid up in the gem, from which the Oak-apple had its riſe, but ſome other ſupervenient, additional inſects laid in, after the apple was grown, and whilſt it was tender and ſoft.

(*cc*) The Aleppo Galls, wherewith we make ink, may be reckoned of this number, being hard, and no other than caſes of inſects which are bred in them: who when come to maturity, gnaw their way out of them; which is the cauſe of thoſe little holes obſervable in them. Of the inſects bred in them, ſee *Philoſ. Tranſact.* N°. 245. Of this number alſo are thoſe little ſmooth caſes, as big as large Pepper-corns, growing cloſe to the ribs under Oaken leaves, globous, but flattiſh; at firſt touched with a bluſhing red, afterwards growing brown, hollow within, and an hard thin ſhell without. In this lieth commonly a rough, white maggot, which becomes a little, long-winged, black Ichneumon-fly, that eats a little hole in the ſide of the Gall, and ſo gets out.

(*dd*) For a ſample of the tender balls, I ſhall chuſe the globous ball, as round, and ſome as big as ſmall muſket-bullets, growing cloſe to the ribs, under Oaken-leaves, of a greeniſh yellowiſh colour, with a bluſh of red; their ſkin ſmooth, with frequent riſings therein. Inwardly they are very ſoft and ſpungy; and in the very center is a caſe with a white maggot therein, which becomes an Ichneumon-fly, not much unlike the laſt. As to this Gall, there is one thing I have obſerved ſomewhat

what peculiar, and I may ſay providential, and that is, that the fly lies all the winter in theſe balls in its infantile ſtate, and comes not to its maturity till the following Spring. In the Autumn, and Winter, theſe balls fall down with their leaves to the ground, and the inſect incloſed in them is there fenced againſt the Winter froſts, partly by other leaves falling pretty thick upon them, and eſpecially by the thick, parenchymous, ſpongy walls, afforded by the Galls themſelves.

Another ſample ſhall be the large Oak-balls, called Oak-apples, growing in the place of the buds, whoſe generation, vegetation, and figure, may be ſeen in Malpig. *de Gallis*, *p*. 24. and *tab*. 10. *fig*. 33, &c. Out of theſe Galls, he ſaith, various ſpecies of flies come, but he names only two; and they are the only two I ever ſaw come out of them: ‘ Frequenter (ſaith he) ſubnigræ ſunt muſ‘ cæ brevi munitæ terebrâ. Inter has aliquæ ob‘ ſervantur aureæ, levi viridis tincturâ ſuffuſæ, ‘ oblongâ pollentes terebrâ.’ Theſe two differently coloured flies I take to be no other than male and female of the ſame ſpecies. I have not obſerved tails (which are their Terebræ) in all, as Malpighi ſeems to intimate: Perhaps they were hid in their Thecæ, and I could not diſcover them: But I rather think there were none, and that thoſe were the males: But in others, I have obſerved long, recurvous tails, longer than their whole bodies. And theſe I take to be the females. And in the Oak-apples themſelves, I have ſeen the Aureliæ, ſome with, ſome without tails. And I muſt confeſs, ’twas not without admiration, as well as pleaſure, that I have ſeen with what exact neatneſs and artifice the tail hath been wrapt about the Aurelia, whereby it is ſecured from either annoying the inſect, or being hurt itſelf.

ſome ſcaly (*ee*), ſome ſmooth (*ff*), ſome hairy (*gg*), ſome long, ſome round, ſome conical,

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(*ee*) See before, *note* (*z*).

(*ff*) As in the preceding note.

(*gg*) Of the rough or hairy excreſcences, thoſe on the Briar, or Dog-roſe, are a good inſtance. Theſe Spongiolæ Villoſæ, as Mr. Ray, Gallæ Rumoſæ, as Dr. Malpighi calls them, are thus accounted for by the latter; 'Ex copioſis relictis ovis 'ita turbatur affluens [Rubi] ſuccus, ut ſtrumoſa 'fiant complura tubercula ſimul confuſè congeſta, 'quæ utriculorum ſeriebus, & fibrarum implica- 'tione contexta, ramoſas propagines germinant, 'ita ut minima quaſi ſylva appareat. Quælibet 'propago ramos hinc inde villoſos edit. Hinc in- 'de pili pariter erumpunt, &c.'

Theſe balls are a ſafe repoſitory to the inſect all the winter in its Vermicular ſtate. For the eggs laid up, and hatched the ſummer before, do not come to mature inſects until the ſpring following, as Mr. Ray rightly obſerves in *Cat. Cantab.*

As to the inſects themſelves, they are manifeſtly Ichneumon-flies, having four wings, their alvus thick and large towards the tail, and tapering up till it is ſmall and ſlender at its ſetting on to the thorax. But the alvi, or bellies, are not alike in all, though coloured alike. In ſome they are as is now deſcribed, and longer, without terebræ, or tails; in ſome ſhorter, with tails; and in ſome yet ſhorter, and thick, like the belly of the Ant, or the heart of animals, as in thoſe before, *note* (*z*). But for a farther deſcription of them I ſhall refer to Mr. Ray, *Cat. Plant. circa Cantab.* under *Roſa ſylveſt.*

conical, &c. (*bb*). And in the laſt place, let us add, that thoſe ſpecies of inſects are all endowed with peculiar, and exactly made, parts for this ſervice, to bore and pierce the vegetable, and to reach and inject their eggs and juice into the tender parts thereof.

(*bb*) It being an inſtance ſomewhat out of the way, I ſhall pitch upon it for an example here; viz. The gouty ſwellings in the body, and the branches of the Blackberry-buſh; of which Malpighi hath given us two good cuts in *tab.* 17. *fig.* 62. The cauſe of theſe is manifeſtly from the eggs of inſects laid in (whilſt the ſhoot is young and tender) as far as the pith, and in ſome places not ſo deep: Which, for the reaſons before mentioned, make the young ſhoots tumify, and grow knotty and gouty.

The inſect that comes from hence is of the former tribe, a ſmall, ſhining black Ichneumon-fly, about a tenth of an inch long, with jointed, red, capillary horns, four long wings, reaching beyond the body, a large thorax, red legs, and a ſhort heart-like belly. They hop like fleas. The males are leſs than the females; are very venereous, endeavouring a Coit in the very box in which they are hatched; getting up on the females, and tickling and thumping them with their breeches and horns, to excite them to venery.

The CONCLUSION.

AND now theſe things being ſeriouſly conſider'd, what leſs can be concluded, than that there is manifeſt deſign and forecaſt in in this caſe, and that there muſt needs be ſome wiſe artiſt, ſome careful, prudent conſervator, that from the very beginning of the exiſtence of this ſpecies of animals, hath with great dexterity and forecaſt, provided for its preſervation and good? For what elſe could contrive and make ſuch a ſet of curious parts, exactly fitted up for that ſpecial purpoſe: and withal implant in the body ſuch peculiar impregnations, as ſhould have ſuch a ſtrange uncouth power on a quite different rank of creatures? And laſtly, what ſhould make the inſect aware of this its ſtrange faculty and power, and teach it ſo cunningly and dextrouſly to employ it for its own ſervice and good?

BOOK IX.

Of REPTILES, *and the Inhabitants of the* Waters.

CHAP. I.

Of REPTILES.

HAVING diſpatch'd the inſect-tribe, there is but one genus of the land-animals, remaining to be ſurvey'd, and that is, that of Reptiles (*a*). Which I ſhall

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(*a*) Notwithſtanding I have before, in *book* iv. *chap.* 12. *note* (*p*), taken notice of the Earth-worm; yet it being a good example of the Creator's wiſe ſhall diſpatch in a little compaſs, by reaſon I have ſomewhat amply treated of others, and many of the things may be applied here. But there

wiſe and curious workmanſhip, in even this meaneſt branch of the creation, I ſhall ſuperadd a few farther remarks from Drs. Willis and Tyſon. Saith Willis, ‘ Lumbricus terreſtris, licèt vile & contemptibile habetur, organa vitalia, necnon & alia viſcera, & membra divino artificio admirabiliter fabrefacta ſortitur: totius corporis compages muſculorum annularium catena eſt, quorum fibræ orbiculares contractæ quemque annulum, prius amplum, & dilatum, anguſtiorem & longiorem reddunt.’ [This muſcle in Earth-worms I find is ſpiral, as in a good meaſure is their motion likewiſe;] ‘ ſo that by this means they can (like the worm of an augre) the better bore their paſſage into the earth. Their reptile motion alſo may be explained by a wire wound on a cylinder, which when ſlipped off, and one end extended, and held faſt, will bring the other nearer it. So the Earth-worm, having ſhot out, or extended its body (which is with a wreathing) it takes hold by thoſe ſmall feet it hath, and ſo contracts the hinder part of its body.’ [Thus the curious and learned Dr. Tyſon, *Philoſ. Tranſact.* N°. 147.] ‘ Nam proinde cùm portio corporis ſuperior elongata, & exporrecta, ad ſpatium alterius extenditur, ibidemque plano affigitur, ad ipſum quaſi ad centrum portio corporis inferior relaxata, & abbreviata facilè pertrahitur. Pedunculi ſerie quadruplici, per totam longitudinem lumbrici diſponuntur; his quaſi totidem uncis, partem modò hanc, modò iſtam plano affigit, dum alteram exporrigit,

there is ſome things in which this tribe is ſomewhat ſingular, which I ſhall therefore take notice of briefly in this place. One is their motion, which I have in another place (*b*) taken notice of to be not leſs curious, than it is different from that of other animals, whether we conſider the manner of it, as vermicular, or ſinuous (*c*), or like that of the ſnail,

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'porrigit, aut poſt ſe ducit. Supra oris hiatum, 'proboſcide, quâ terram perforat & elevat, dona-'tur.' And then he goes on with the other parts that fall under view, the brain, the gullet, the heart, the ſpermatick veſſels, the ſtomachs and inteſtines, the foramina on the top of the back, adjoining to each ring, ſupplying the place of lungs, and other parts. Willis *de Anim. Brut. p.* 1. *c.* 3.

(*b*) In *book* iv. *chap.* 8.

(*c*) There is a great deal of geometrical neatneſs and nicety in the ſinuous motion of ſnakes, and other ſerpents. For the aſſiſting in which action, the annular ſcales under their body are very remarkable, lying croſs the belly, contrary to what thoſe in the back, and the reſt of the body do; alſo as the edges of the foremoſt ſcales lie over the edges of their following ſcales, from head to tail; ſo thoſe edges run out a little beyond, or over their following ſcales; ſo as that when each ſcale is drawn back, or ſet a little upright, by its muſcle, the outer edge thereof (or foot it may be called) is raiſed alſo a little from the body, to lay hold on the earth, and ſo promote and facilitate the ſerpent's motion. This is what may be eaſily ſeen in the ſlough, or belly of the ſerpent kind. But there is another admirable piece of mechaniſm that my antipathy ſnail (*d*), or the caterpillar (*e*), or the multipedous,

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tipathy to thoſe animals hath prevented my prying into; and that is, that every ſcale hath a diſtinct muſcle, one end of which is tacked to the middle of its ſcale; the other, to the upper edge of its following ſcale. This Dr. *Tyſon* found in the Rattle-ſnake, and I doubt not is in the whole tribe.

(*d*) The wiſe Author of Nature having denied feet and claws to enable Snails to creep and climb, hath made them amends in a way more commodious for their ſtate of life, by the broad ſkin along each ſide of the belly, and the undulating motion obſervable there. By this latter it is they creep; by the former, aſſiſted with the glutinous ſlime emitted from the Snail's body, they adhere firmly and ſecurely to all kinds of ſuperfices, partly by the tenacity of their ſlime, and partly by the preſſure of the atmoſphere. Concerning this part (which he calls the Snail's feet) and their undulation, ſee Dr. Liſter's *Exercit. Anat.* 1. §. 1, & 37.

(*e*) The motive parts, and motion of Caterpillars, are uſeful, not only to their progreſſion and conveyance from place to place; but alſo to their more certain, eaſy, and commodious gathering of food: For having feet before and behind, they are not only enabled to go by a kind of ſteps made by their fore and hind parts; but alſo to climb up vegetables, and to reach from their boughs and ſtalks for food at a diſtance; for which ſervices their feet are very nicely made, both before and behind. Behind they have broad palms for ſticking to, and theſe beſet almoſt round with ſmall ſharp nails, to hold and graſp what they are upon: Before, their

feet

pedous (*f*), or any other way; or the parts miniſtring to it, particularly the ſpine (*g*), and the muſcles co-operating with the ſpine, in

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feet are ſharp and hooked, to draw leaves, &c. to them, and to hold the fore-part of the body, whilſt the hinder-parts are brought up thereto. But nothing is more remarkable in theſe reptiles, than that theſe parts and motions are only temporary, and incomparably adapted only to their preſent Nympha ſtate; whereas in their Aurelia ſtate, they have neither feet nor motion, only a little in their hinder-parts: And in their Mature ſtate, they have the parts and motion of a flying inſect, made for flight.

(*f*) It is a wonderful pretty mechaniſm, obſervable in the going of Multipedes, as the Juli, Scolopendræ, &c. that on each ſide the body, every leg hath its motion, one very regularly following the other, from one end of the body to the other, in a way not eaſy to be deſcribed in words; ſo that their legs in going make a kind of undulation, and give the body a ſwifter progreſſion than one would imagine it ſhould have, where ſo many feet are to take ſo many ſhort ſteps.

(*g*) ‘Vertebrarum Apophyſes breviores ſunt, præcipue juxta caput, cujus propterea flexus in averſum, & latera, facilis Viperis eſt; ſecus Leonibus, &c.----Incumbit his Oſſibus ingens Muſculorum minutorum præſidium, tum ſpinas tendinum exilium magno apparatu deducentium, tum vertebras potiſſimum in diverſa flectentium, atque erigentium. Adeoque illam corporis miram agilitatem, non tantùm (ut Ariſtot.) ὅτι εὐκαμπεῖς ϗ χονδρώδεις οἱ σπόνδυλοι, quoniam faciles ad flexum, & cartilagineas produxit vertebras, ſed

‘quia

ſuch as have bone, and the annular, and other muſcles, in ſuch as have none, all incomparably made for thoſe curious, and, I may ſay, geometrical windings and turnings, undulations, and all the various motions to be met with in the reptile kind.

Another thing that will deſerve our notice, is, the poiſon (*b*) that many of this tribe are ſtock'd

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'quia etiam multiplicia motûs localis inſtrumenta 'muſculos fabrefecit provida rerum Parens Natura, 'conſecuta fuit.' Blaſ. *Anat. Anim. p.* 1. *c.* 39. *de Viperâ è Veſtingio.*

'That which is moſt remarkable in the vertebræ '[of the Rattle-ſnake, beſides the other curious 'articulations] is, that the round ball in the lower 'part of the upper vertebra enters a ſocket of the 'upper part of the lower vertebra, like as the 'head of the Os Femoris doth the Acetabulum of 'the Os Iſchii; by which contrivance, as alſo the 'articulation with one another, they have that 'free motion of winding their bodies any way.' Dr. Tyſon's *Anat. of the Rattle-ſnake,* in *Philoſ. Tranſact.* N°. 144. What is here obſerved of the vertebræ of this Snake, is common to this whole genus of reptiles.

(*b*) My ingenious and learned friend, Dr. Mead, examined with his microſcope, the texture of a Viper's poiſon, and found therein at firſt only 'a parcel of ſmall ſalts nimbly floating in the liquor; but in a ſhort time the appearance was 'changed, and theſe ſaline particles were ſhot out 'into cryſtals, of an incredible tenuity and ſharpneſs, with ſomething like knots here and there, 'from which they ſeemed to proceed; ſo that the 'whole texture did in a manner repreſent a ſpi-

'der's

ſtock'd with. Which I the rather mention, becauſe ſome make it an objection againſt the divine ſuperintendence and providence, as being a thing ſo far from uſeful (they think) that 'tis rather miſchievous and deſtructive of God's creatures. But the anſwer is eaſy; viz. That as to man, thoſe creatures are not without their great uſes, particularly in the cure

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'der's web, though infinitely finer.' Mead *of Poiſons, p.* 9.

As to the nature and operation of this poiſon, ſee the ſame ingenious author's hypotheſis, in his following pages.

This poiſon of the Viper lieth in a bag in the gums, at the upper end of the teeth. It is ſeparated from the blood by a conglomerated gland, lying in the anterior lateral part of the Os Sincipitis, juſt behind the orbit of the eye: From which gland lieth a duct, that conveys the poiſon to the bags at the teeth.

The teeth are tubulated, for the conveyance, or emiſſion of the poiſon into the wound the teeth make; but their hollowneſs doth not reach to the Apex, or top of the tooth (that being ſolid and ſharp, the better to pierce) but it ends in a long ſlit below and point, out of which the poiſon is emitted. Theſe perforations of the teeth, *Galen* ſaith, the mountebanks uſed to ſtop with ſome kind of paſte, before they ſuffered the Vipers to bite them before their ſpectators. Cuts of theſe parts, &c. may be ſeen in the laſt cited book of Dr. *Mead*. Alſo Dr. Tyſon's *Anat. of the Rattle-ſnake*, in *Philoſ. Tranſ.* N°. 144.

cure of (*i*) ſome of the moſt ſtubborn diſeaſes; however, if they were not, there would be no

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(*i*) That Vipers have their great uſes in phyſick, is manifeſt, from their bearing a great ſhare in ſome of our beſt antidotes, ſuch as Theriaca Andromachi, and others; alſo in the cure of the Elephantiaſis, and other the like ſtubborn maladies, for which I ſhall refer to the medical writers. But there is ſo ſingular a caſe, in the curious collection of Dr. Ol. Worm. related from Kircher, that I ſhall entertain the reader with it. Near the village of Saſſa, about eight miles from the city Bracciano in Italy, ſaith he, 'Specus ſeu caverna (vulgò La 'Grotta del Serpi) duorum hominum capax, fiſtu-'loſis quibuſdam foraminibus in formam cribri 'perforata cernitur, ex quibus ingens quædam, 'principio veris, diverſicolorum Serpentum, nullâ 'tamen, ut dicitur, ſingulari veneni qualitate im-'butorum progenies quotannis pullulare ſolet. In 'hâc ſpeluncâ Elephantiacos, Leproſos, Paralyti-'cos, Arthriticos, Podagricos, &c. nudos exponere 'ſolent, qui mox halituum ſubterraneorum calore 'in ſudorem reſoluti, Serpentum propullulantium, 'totum corpus infirmi implicantium, ſuctu linctu-'que ita omni vitioſo virulentoque humore privare 'dicuntur, ut repetito hoc per aliquod tempus me-'dicamento, tandem perfectæ ſanitati reſtituan-'tur.' This cave Kircher viſited himſelf, found it warm, and every way agreeable to the deſcription he had of it; he ſaw their holes, heard a murmuring hiſſing noiſe in them; but altho' he miſſed ſeeing the Serpents (it being not the ſeaſon of their creeping out) yet he ſaw great numbers of their Exuviæ, or Sloughs, and an Elm growing hard by, laden with them.

no injuſtice for God to make a ſet of ſuch noxious creatures, as rods and ſcourges, to execute the divine chaſtiſements upon ungrateful and ſinful men. And I am apt to think that the nations which know not God, are the moſt annoy'd with thoſe noxious reptiles, and other pernicious creatures. As to the animals themſelves, their poiſon is, no doubt, of ſome great and eſpecial uſe to themſelves, ſerving to the more eaſy conqueſt, and ſure capture of their prey, which might otherwiſe be too reſty and ſtrong, and if once eſcaped, would hardly be again recover'd, by reaſon of their ſwifter motion, and the help of their legs; beſides all which, this their poiſon may probably be of very great uſe to the digeſtion of their food. And

The diſcovery of this cave, was by the cure of a leper going from Rome to ſome baths near this place; who loſing his way, and being benighted, happened upon this cave; and finding it very warm, pulled off his cloaths, and being weary and ſleepy, had the good fortune not to feel the Serpents about him till they had wrought his cure. *Vide Muſeum, Worm.* l. 3. *c.* 9.

The before-commended Dr. Mead thinks our phyſicians deals too cautiouſly and ſparingly, in their preſcribing only ſmall quantities of the Viper's fleſh, &c. in the Elephantiaſis, and ſtubborn Leproſies: But he recommended rather the gelly or broth of Vipers; or, as the ancient manner was, to boil Vipers, and eat them like fiſh; or at leaſt to drink wine, in which they have been long infuſed. *Vide* Mead, *ubi ſupra, p.* 34.

And as to the innocuous part of the reptile-kind, they as well deſerve our notice for their harmleſneſs, as the others did for their poiſon. For as thoſe are endowed with poiſon, becauſe they are predaceous; ſo theſe need it not, becauſe their food is near at hand, and may be obtain'd without ſtrife and conteſt, the next earth (*k*) affording food to ſuch as terebrate, and make way into it by their vermicular faculty; and the next vegetable being food to others that can climb and reach (*l*), or but crawl to it.

(*k*) That Earth-worms live upon earth, is manifeſt from the little curled heaps of their dung ejected out of their holes. But in *Philoſ. Tranſact.* N°. 291. I have ſaid, it is in all probability earth made of rotted roots and plants, and ſuch like nutritive things, not pure earth. And there is farther reaſon for it, becauſe worms will drag the leaves of trees into their holes.

(*l*) Snails might be in danger of wanting food, if they were to live only upon ſuch tender plants as are near the ground, within their reach only: To impower them therefore to extend their purſuits farther, they are enabled, by the means mentioned in *note* (*d*), to ſtick unto, and creep up walls and vegetables at their pleaſure.

CHAP.

CHAP. II.

Of the Inhabitants of the Waters.

I Have now gone through that part of the animal world which I propoſed to ſurvey, the animals inhabiting the land.

As to the other part of the terraqueous globe, the waters, and the inhabitants thereof, not having time to finiſh what I have begun on that large ſubject, I ſhall be forced to quit it for the preſent, although we have there as ample and glorious a ſcene of the infinite Creator's power and art, as hath been already ſet forth on the dry land. For the waters themſelves are an admirable work of God (*a*), and of infinite uſe (*b*) to that part of the globe already

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(*a*) Beſides their abſolute neceſſity, and great uſe to the world, there are ſeveral topics, from whence the waters may be demonſtrated to be God's work; as, the creating ſo vaſt a part of our globe; the placing it commodiouſly therein, and giving it bounds; the methods of keeping it ſweet and clean, by its ſaltneſs, by the tides, and agitations by the winds; the making the waters uſeful to the vegetation of plants, and for food to animals, by the noble methods of ſweetning them; and many other things beſides, which are inſiſted on in that part of my ſurvey.

(*b*) Pliny having named divers Mirabilia Aquarum, to ſhew their power, then proceeds to their uſes; viz. ' Eædem cadentes omnium terrâ naſ- ' centium ready ſurvey'd; and the prodigious variety (*c*), and multitudes of curious and wonderful things obſervable in its inhabitants of all ſorts, are an inexhauſtible ſcene of the Creator's wiſdom and power. The vaſt bulk of ſome (*d*), and prodigious minuteneſs of others (*e*), together with the incomparable contrivance and ſtructure

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'centium cauſa fiunt, prorſus mirabili naturâ, 'ſiquis velit reputare, ut fruges gignantur, arbores 'fruticeſque vivant, in cœlum migrare aquas, ani'mamque etiam herbis vitalem inde deferre, juſtâ 'confeſſione, omnes terræ quoque vires aquarum 'eſſe beneficii. Quapropter ante omnia ipſarum 'potentiæ exempla ponemus: Cunctas enim quis 'mortalium enumerare queat?' And then he goes on with an enumeration of ſome waters famed for being medicinal, or ſome other unuſual quality. Plin. *l.* 31. *c.* 1, 2.

(*c*) Pliny reckons 176 kinds in the waters, whoſe names may be met with in his *l.* 32. *c.* 11. but he is ſhort in his account.

(*d*) Pliny, *l.* 9. *c.* 3. ſaith, that in the Indian ſea there are 'Balenæ quaternûm jugerum (*i. e.* '960 feet) Priſtes 200 cubitorum (*i. e.* 300 feet).' And *l.* 32. *c.* 1. he mentions Whales 600 foot long, and 360 broad, that came into the river of Arabia. If the reader hath a mind, he may ſee his reaſon why the largeſt animals are bred in the ſea, *l.* 9. *c.* 2.

(*e*) As the largeſt ſo the moſt minute animals are bred in the waters, as thoſe in Pepper-water; and ſuch as make the green ſcum on the waters, or make them ſeem as if green, and many others. See *book* iv. *chap.* 11. *notes* (*n*) (*o*).

ture of the bodies of all (*f*); the proviſions and ſupplies of food afforded to ſuch an innumerable company of eaters, and that in an element unlikely, one would think, to afford any great ſtore of ſupplies (*g*); the buſineſs of reſpiration perform'd in a way ſo different from, but equivalent to what is in land animals (*h*); the adjuſtment of the organs of viſion

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(*f*) It might be here ſhewn, that the bodies of all the ſeveral inhabitants of the waters, are the beſt contrived and ſuited to that place and buſineſs in the waters which is proper for them; that particularly their bodies are cloathed and guarded, in the beſt manner, with ſcales, or ſhells, &c. ſuitable to the place they are to reſide in, the dangers they may there be expoſed unto, and the motion and buſineſs they are there to perform: That the center of gravity (of great conſideration in that fluid element) is always placed in the fitteſt part of the body: That the ſhape of their bodies (eſpecially the more ſwift) is the moſt commodious for making way through the waters, and moſt agreeable to geometrical rules; and many other matters beſides, would deſerve a place here, were they not too long for notes, and that I ſhall anticipate what ſhall be more proper for another place, and more accurately treated of there.

(*g*) See before, *book* iv. *chap.* 11.

(*h*) Galen was aware of the reſpiration of fiſhes by their Branchiæ. For having ſaid, that fiſhes have no occaſion for a voice, neither reſpire through the mouth as land animals do, he ſaith, 'Sed 'earum, quas Branchias nuncupamus, conſtructio, 'ipſis vice Pulmonis eſt. Cùm enim crebris ac 'tenuibus ſion (*i*) to that element in which the animal liveth; the poiſe (*k*), the ſupport (*l*), the motion

'tenuibus foraminibus ſint Branchiæ hæ intercep'tæ, aëri quidem & vapori perviis, ſubtilioribus 'tamen quàm pro mole aquæ; hanc quidem ex'tra repellunt, illa autem promptè intromittunt.' Galen *de Uſ. Part. l.* 6. *c.* 9. So alſo Pliny held, that fiſhes reſpired by their gills; but he ſaith Ariſtotle was of a different opinion. Plin. *l.* 9. *c.* 7. And ſo Ariſtotle ſeems to be in his *Hiſtory of Animals*, *l.* 8. *c.* 2. and in other places. And I may add our famous Dr. Needham. See his *De Form. Fœtu*, *chap.* 6. and *Anſwer to* Severinus.

(*i*) A protuberant eye would have been inconvenient for fiſhes, by hindering their motion in ſo denſe a medium as water is; or elſe their bruſhing through ſo thick a medium would have been apt to wear, and prejudice their eyes; therefore their Cornea is flat. To make amends for which, as alſo for the refraction of water, different from that of the air, the wiſe Contriver of the eye hath made the Cryſtalline ſpherical in fiſhes, which in animals, living in the air, is lenticular, and more flat.

(*k*) As I have ſhewed before, that the bodies of birds are nicely poiſed to ſwim in the air, ſo are thoſe of fiſhes for the water, every part of the body being duly balanced, and the center of gravity (as I ſaid in *note* (*f*) accurately fixed. And to prevent vacillation, ſome of the fins ſerve, particularly thoſe of the belly; as Borelli proved, by cutting off the belly-fins, which cauſed the fiſh to reel to the right and left hand, and render'd it unable to ſtand ſteadily in an upright poſture.

(*l*) To enable the fiſh to abide at the top, or bottom, or any other part of the waters, the air-bladder tion of the body (*m*), forwards with great ſwiftneſs, and upwards and downwards with great readineſs and agility, and all without feet and hands, and ten-thouſand things beſides: All theſe things, I ſay, do lay before us ſo various, ſo glorious, and withal ſo inexhauſtible a ſcene of the divine power, wiſdom, and goodneſs, that it would be in vain to engage myſelf in ſo large a province, without allotting as much time and pains to it, as the preceding ſurvey hath coſt me. Paſſing by therefore that part of our globe, I ſhall only ſay ſomewhat very briefly concerning the inſenſitive creatures, particularly thoſe of the vegetable kingdom, and ſo conclude this ſurvey.

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bladder is given to moſt fiſhes, which, as it is more full or empty, makes the body more or leſs buoyant.

(*m*) The tail is the grand inſtrument of the motion of the body; not the fins, as ſome imagine. For which reaſon, fiſhes are more muſculous and ſtrong in that part, than in all the reſt of their body, according as it is in the motive parts of all animals, in the pectoral muſcles of birds, the thighs of man, &c.

If the reader hath a mind to ſee the admirable method, how fiſhes row themſelves by their tail, and other curioſities relating to their ſwimming; I ſhall refer him to Borelli *de Mot. Animal. Part.* I. *chap.* 23. particularly to *Prop.* 213.

BOOK

BOOK X.

Of Vegetables.

THE vegetable kingdom, although an inferior branch of the Creation, exhibits to us ſuch an ample ſcene of the Creator's contrivance, curioſity, and art, that I much rather chuſe to ſhew what might be ſaid, than engage too far in particulars. I might inſiſt upon the great variety there is, both of trees and plants, provided for all ages, and for every uſe and occaſion of the world (*a*); ſome for building, for tools and utenſils of every kind; ſome hard, ſome ſoft; ſom tough and ſtrong, ſome brittle; ſome long and tall, ſome ſhort and low; ſome thick an large, ſome ſmall and ſlender; ſome fo phyſick (*b*); ſome for food, ſome for plea

ſure;

(*a*) The fifth book of Theophraſtus's *Hiſtory o Plants* may be here conſulted; where he gives ample inſtances of the various conſtitutions and uſe of trees, in various works, &c. See alſo befor *book* iv. *chap.* 13. *note* (*a*).

(*b*) ‘ Inviſis quoque herbis inſeruit [Natura] re
‘ media: quippe cùm medicinas dederit etiam acu
‘ leatis----in quibus ipſis providentiam Naturæ ſa
‘ tis admirari amplectique non eſt.----Inde excog
‘ tavit aliquas aſpectu hiſpidas, tactu truces,
‘ tantùm non vocem ipſius fingentis illas, ratio

‘ nemqu

ſure; yea, the moſt abject (*c*) ſhrubs, and the very bruſhes and brambles themſelves, the huſbandman can teſtify the uſe of.

I might

'nemque reddentis exaudire videamur, ne ſe depaſcat avida Quadrupes, ne procaces manus rapiant, ne neglecta veſtigia obterant, ne inſidens Ales infringat: his muniendo Aculeis, teliſque armando, remediis ut tuta ac ſalva ſint. Ita hoc quoque quod iis odimus, hominum cauſâ excogitatum.' Plin. *Nat. Hiſt. l.* 22. *c.* 6.

'Are ſome of the ſpecies of nature noxious? They are alſo uſeful.----Doth a nettle ſting? It is to ſecure ſo good a medicine from the rapes of children and cattle. Doth the bramble cumber a garden? It makes the better hedge; where if it chanceth to prick the owner, it will tear the thief.' Grew's *Coſmolog. lib.* 3. *cap.* 2. §. 47.

(*c*) That the moſt abject vegetables, &c. have their uſe, and are beneficial to the world, may in ſome meaſure appear from the uſe the Northern people put rotten wood, &c. unto. 'Satis ingenioſum modum habent populi ſeptentrionales in nemoribus nocturno tempore pertranſeuntes, imo & diurno, quando in remotioribus aquilonis partibus ante, & poſt ſolſtitium hyemale continuæ noctes habentur. Quique his remediis indigent, cortices quercinos inquirunt putres, eoſque collocant certo interſtitio itineris inſtituti, ut eorum ſplendore, quo voluerint, perficiant iter. Nec ſolùm hoc præſtat cortex, ſed & truncus putrefactus, ac fungus ipſe agaricus appellatus, &c.' Ol. Mag. *Hiſt. l.* 2. *c.* 16.

To this we may add Thiſtles in making glaſs, whoſe aſhes, Dr. *Merret* ſaith, are the beſt; viz. the

I might alſo ſurvey here the curious anatomy and ſtructure of their bodies (*d*), and ſhew the admirable proviſion made for the conveyance of the lymphatick and eſſential juices, for communicating the air, as neceſſary

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the aſhes of the common-way Thiſtle, though all Thiſtles ſerve to this purpoſe. Next to Thiſtles are Hop-ſtrings, cut after the flowers are gathered. Plants that are thorny and prickly, ſeem to afford the beſt and moſt ſalt. Merret's *Obſervations on Anton. Ner. p.* 265.

Quid majora ſequar? Salices, humileſque Geniſtæ,
Aut illæ pecori frondem, aut paſtoribus umbram
Sufficiunt, ſepemque ſatis, & pabula melli.
Virg. Georg. l. 2. ver. 434.

(*d*) Dr. *Beal* (who was very curious, and tried many experiments upon vegetables) gives ſome good reaſons to imagine, that there is a direct communication between the parts of the tree and the fruit; ſo that the ſame fibres which conſtitute the root, trunk and boughs, are extended into the very fruit. And in old Horn-beans, I have obſerved ſomething very like this; in many of which, there are divers great and ſmall ribs (almoſt like ivy, only united to the body) running from the root up along the out-ſide of the body, and terminating in one ſingle, or a few boughs: which bough or boughs ſpread again into branches, leaves, and fruit. See what Dr. *Beal* hath in Lowth. *Abridg. vol.* II. *p.* 710.

But as to the particular canals, and other parts relating to the anatomy of vegetables, it is too long a ſubject for this place, and therefore I ſhall refer to Seign. *Malpighi*'s and Dr. *Grew*'s labours in this kind.

ſary to vegetable, as animal life (*e*); I might alſo ſpeak of, even the very covering they are provided with, becauſe it is a curious work in reality, although leſs ſo in appearance: and much more therefore might I ſurvey the neat

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(*e*) 'Tanta eſt reſpirationis neceſſitas, & uſus, 'ut natura in ſingulis viventium ordinibus varia, 'ſed analoga, paraverit inſtrumenta, quæ pulmones vocamus [and ſo he goes on with obſerving 'the apparatus made in the various genera of animals, and then ſaith] In plantis verò, quæ infimum animalium attingunt ordinem, tantum tra'chearum copiam & productionem extare par eſt, 'ut his minimæ vegetantium partes præter corticem irrigentur----- Plantæ igitur (ut conjectari 'fas eſt) cùm ſint viventia, viſceribus infixa terræ, 'ab hac, ſeu potius ab aquâ & aëre, commixtis & 'percolatis à terrâ, reſpirationis ſuæ materiam recipiunt, ipſarumque tracheæ ab halitu terræ, ex'tremas radices ſubingreſſo, replentur.' Malpig. *Op. Anat. Plant. p.* 15.

Theſe Tracheæ, or Air-veſſels, are viſible, and appear very pretty in the leaf of Scabious, or the vine, by pulling aſunder ſome of its principal ribs, or great fibres; between which, may be ſeen the ſpiral Air-veſſels (like threads of cobweb) a little uncoiled: A figure whereof Dr. *Grew* hath given us in his *Anat. Plant. fig.* 51, 52.

As to the curious coiling, and other things relating to the ſtructure of thoſe Air-veſſels, I refer to *Malpig. p.* 14. and Dr. *Grew, ib. l.* 3. *c.* 3. § 16, *&c.* and *l.* 4. *c.* 4. § 19. of Mr. *Ray*, from them ſuccinctly. *Hiſt. Plant. l.* 1. *c.* 4.

neat variety and texture of their leaves (*f*), the admirable finery, gaiety, and fragrancy of their

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(*f*) Concerning the leaves, I ſhall note only two or three things: 1. As to the fibres of the leaf, they ſtand not in the ſtalk, in an even line, but always in an angular or circular poſture, and their vaſcular fibres or threads are 3, 5, or 7. The reaſon of their poſition thus, is for the more erect growth and greater ſtrength of the leaf, as alſo for the ſecurity of its ſap. Of all which ſee Dr. Grew, *l.* 1. *c.* 4. §. 8, &c. and *l.* 4. *par.* 1. *c.* 3. alſo *tab.* 4. *fig.* 2, to 11. Another obſervable in the fibres of the leaf, is their orderly poſition, ſo as to take in an eighth part of a circle, as in Mallows; in ſome a tenth, but in moſt a twelfth, as in Holyoak; or a ſixth, as in Syringa. *Id, ib. tab.* 46, 47.

2. The art in folding up the leaves, before their eruption out of their gems, &c. is incomparable, both for its elegancy and ſecurity, viz. ‘In taking ‘up (ſo as their forms will bear) the leaſt room; ‘and in being ſo conveniently couched as to be capable of receiving protection from other parts, ‘or of giving it to one another, *e.g.* Firſt, there ‘is the bow lap, where the leaves are all laid ‘ſomewhat convexly one over another, but not ‘plaited----but where the leaves are not ſo thick ‘ſet, as to ſtand in the bow-lap, there we have ‘the plicature, or the flat-lap; as in Roſe-trees, ‘&c.’ And ſo that curious obſerver goes on, ſhewing the various foldings, to which he gives the names of the Duplicature, Multiplicature, the Fore-rowl, Back-rowl, and Tre-rowl, or Treble-rowl. Grew, *ib. l.* 1. *c.* 4. §. 14, &c. To theſe he adds ſome

their flowers (*g*). I might alſo enquire into the

ſome others, *l.* 4. *p.* 1. *c.* 1. §. 9. Conſult alſo Malpig. *de Gemmis*, *p.* 22, &c.

To theſe curious foldings we may add another noble guard by the interpoſition of Films, &c. of which Dr. Grew ſaith, there are about ſix ways; viz. Leaves, Sur-foils, Inter-foils, Stalks, Hoods, and Mantlings. Grew, *ib.* and *tab.* 41, 42. Malpig. *ib.*

(*g*) In the flower may be conſidered the empalement, as Dr. Grew; the calix, or perianthium, as Mr. Ray, and others call it, deſigned to be a ſecurity, and bands to the other parts of the flower. 'Floris velut baſis & fulcimentum eſt.' Ray *Hiſt.* *l.* 1. *c.* 10. Flowers, whoſe petala are ſtrong (as Tulips) have no calix. Carnations, whoſe petala are long and ſlender, have an empalement of one piece: And others, ſuch as the Knap-weeds, have it conſiſting of ſeveral pieces, and in divers rounds, and all with a counterchangeable reſpect to each other, for the greater ſtrength and ſecurity of themſelves, and the petala, &c. they include.

The next is the foliation, as Dr. Grew, the petala or folia, as Mr. Ray, and others. In theſe, not only the admirable beauty, and luxuriant colours are obſervable, but alſo their curious foldings in the calix, before their expanſion. Of which Dr. *Grew* hath theſe varities; viz. The Cloſe-couch, as in Roſes; the Concave-couch, as in Blattaria flore albo; the Single-plait, as in Peaſe-bloſſoms; the Double-plait, as in Blue-bottles, &c. the Couch and Plait together, as in Marigolds, &c. the Rowl, as in Ladies-Bower; the Spire, as in Mallows; and laſtly, the Plait and Spire together, as the wonderful generation and make of the ſeed (*h*), and the great uſefulneſs of their fruit: I might ſhew that the rudiments and lineaments of the parent-vegetable, though never ſo large and ſpacious, is lock'd up in the little compaſs of their fruit or ſeed, though ſome of theſe ſeeds are ſcarce viſible to the naked eye (*i*). And foraſmuch as the perpetuity

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as in Convolvulus Doronici folio. *Lib.* 1, *cap.* 5, §. 6. and *tab.* 54.

As to the Stamina with their Apices, and the Stylus (called the Attire, by Dr. *Grew*) they are admirable, whether we conſider their colours, or make, eſpecially their uſe, if it be as Dr. *Grew*, Mr. *Ray*, and others imagine; namely, as a Male Sperm, to impregnate and fructify the ſeed. Which opinion is corroborated by the ingenious obſervations of Mr. *Samuel Morland*, in *Philoſ. Tranſact.* N°. 287.

' Reliqua uſûs alimentique gratiâ genuit [Na-
' tura] ideoque ſecula annoſque tribuit iis. Flores
' verò odoreſque in diem gignit: magnâ (ut pa-
' lam eſt) admonitione hominum, quæ ſpectatiſſimè
' floreant, celerrimè marceſcere.' Plin. *Nat. Hiſt.* *l.* 21. *c.* 1.

(*h*) As to the curious and gradual proceſs of nature in the formation of the ſeed or fruit of vegetables, cuts being neceſſary, I ſhall refer to Dr. Grew, *p.* 45. and 209. and Malpig. *p.* 57.

(*i*) ' Vetus eſt Empedoclis dogma, Plantaru
' ſemina Ova eſſe, ab iiſdem decidua----Ineſt in e
' [Ovo vel Semine] velut in cicatrice, non ſol
' viventis carina, ſed cum minimo trunco aſſur-
' gentes partes, gemma ſcilicet, & inſignis radici
' canas,

petuity and ſafety of the ſpecies depends upon

‘ canas, &c.’ Malpig. *ib. p.* 81. Vid. plura in tract. *de Seminum veget.* p. 14. & paſſim.

In *Malpighi*’s Life, a debate may be ſeen between him and Seign. *Triumphetti*, the provoſt of the garden at *Rome*, whether the whole plant be actually in the ſeed. The affirmative is maintained by *Malpighi*, with cogent arguments; among which, this is one: ‘ Non præoccupatâ mente, oculis microſcopio armatis, luſtret quæſo Phaſeolorum ſeminalem plantulam nondum ſatam, in quâ folia ſtabilia, hæcque ampla evidenter obſervabit; in eâdem pariter gemmam, nodos, ſeu implantationes varias foliorum caulis deprehendet. Caulem inſignem fibris ligneis, & utriculorum ſeriebus conſtantem conſpicuè attinget.’ And whereas Seign. *Triumphetti* had objected, that ‘ Vegetatione, metamorphoſi, inediâ plantas in alias degenerare, ut exemplo plurium [conſtat] præcipuè tritici in lolium, & lolii in triticum verſi.’ In anſwer to this (which is one of the ſtrongeſt arguments againſt *Malpighi*’s aſſertion) *Malpighi* replies, ‘ Nondum certum eſt de integritate, & ſucceſſu experimenti, nam facienti mihi, & amicis, tritici metamorphoſis non ceſſit. Admiſſa tamen metamorphoſi, quoniam hæc neglecta cultura, aût vitio ſoli, aut aeris contingit----ideo ex morboſo & monſtruoſo affectu non licet inferre permanentem ſtatum à Naturâ intentum. Obſervo plantas ſylveſtres culturâ varias reddi, &c.’ I have more largely taken notice of *Malpighi*’s anſwer, becauſe he therein ſhews his opinion about the tranſmutation of vegetables. *Vide* Malpig. *Vit. p.* 67.

upon the ſafety of the ſeed and fruit in a great meaſure, I might therefore take notice of the

peculiar

So Mr. *Leuwenhoeck*, after his nice obſervations of an Orange-kernel, which he made to germinate in his pocket, &c. concludes, 'That we ſee, how ſmall a particle, no bigger than a coarſe ſand (as the plant is repreſented) is increaſed, &c. A plain demonſtration, that the plant, and all belonging to it, was actually in the ſeed, in the young plant, its body, root, &c.' *Philoſ. Tranſact.* N°. 287. See alſo Raii, *Cat. Cant.* in *Acer. maj.* from Dr. *Highmore*. But in all the ſeeds which I have viewed, except the Maple, the plant appears the plaineſt to the naked eye, and alſo very elegant in the Nux Vomica.

'Natura non obſervat magnitudinis proportionem inter ſemina & plantas ab iiſdem ortas, ita ut majus ſemen majorem ſemper producat plantam, minis minorem. Sunt enim in genere herbarum non pauca, quarum ſemina arborum nonnullarum ſeminibus non dico æqualia ſunt, ſed multa majora. Sic *v. g.* Semina Fabæ, &c. ſemina Ulmi, &c. multis vicibus magnitudine ſuperant.' Raii *ubi ſuprà*, *l.* 1. *c.* 13.

'Filicem reliquaſque Capillares herbas Semine carere Veteres plerique----prodidere; quos etiam ſecuti ſunt è Recentioribus nonnulli, Dodonæus, &c.-----Alii è contrà, Bauhinus, &c. Filices & congeneres ſpermatophoras eſſe contendunt; partim quia Hiſtoria Creationis, *Geneſ.* ii. 12, &c. ------hanc ſententiam veriſſimam eſſe----autopſia convincit.' *Fredericus Cæſius*, he ſaith, was the firſt that diſcovered theſe ſeeds, with the help of a microſcope. And ſince him, Mr. *W. C.* hath more critically obſerved them. Among other things ob-

ſerved

peculiar care the great God of nature hath taken for the conſervation and ſafety hereof: as particularly in ſuch as dare to ſhew their heads all the year, how ſecurely their flower, ſeed, or fruit, is locked up all the winter, together with their leaves and branches, in their gems (*k*), and well fenced and covered there with

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ſerved by that ingenious gentleman, are theſe, ‘Pixidulæ ſeu capſulæ ſemina continentes in pleriſque hoc genus plantis perquam exili granulo arenæ vulgaris cinereæ plus duplo minores ſunt; imò in nonnullis ſpeciebus vix tertiam quartamve arenulæ partem magnitudine æquant, veſicularum quarundam annulis aut faſciolis vermiformibus obvolutarum ſpeciem exhibentes. Nonnullæ ex his veſiculis 100 circiter ſemina continere deprehendebantur------adeò eximiâ parvitate ut nudo oculo prorſus eſſent inviſibilia, nec niſi microſcopii interventu detegi poſſent.----- Oſmunda Regalis, quæ aliis omnibus Filicis ſpeciebus mole----antecellit----vaſcula ſeminalis obtinet æquæ cum reliquis congeneribus magnitudinis-----quorum immenſa & viſum fugiens parvitas cum magnitudine plantæ collata-----adeò nullam gerere proportionem invenietur, ut tantam plantam è tantillo ſemine produci attentum obſervatorem meritò in admirationem rapiat.’ Ray, *ibid. l.* 3. *p.* 132. This *W. C.* was Mr. *William Cole*, as he owneth in a letter I have now in my hands of his to Mr. *Ray*, of *Octob.* 18, 1684.

(*k*) ‘Vegetantium genus, ut debitam magnitudinem ſortiatur, & ſuæ mortalitatis jacturam ſucceſſivâ prolis eductione reparet, ſtatis temporibus with neat and cloſe tunicks. And for ſuch as dare not ſo to expoſe themſelves, with what ſafety are they preſerved under the coverture of the earth, in their root (*l*), ſeed,

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'ribus novas promit partes, ut tandem emergentes 'Uteri recentes edant Soboles. Emanantes igitur 'à caule, caudice, ramis, & radicibus novellæ 'hujuſmodi partes, non illico laxatæ extenduntur, 'ſed compendio quodam coagmentatæ intra folii 'axillam cubantes, non parum ſubſiſtunt, gemmæ 'appellantur, &c.' And then that great man goes on to ſhew the admirable various methods of nature, in repoſiting, in that little compaſs, ſo large a part of a tree or plant, the curious ſtructure of the gems, the admirable guard afforded them, and the leaves, flowers, and ſeed contained in them, &c. Of which having taken notice before, I paſs over it now, and only refer to our author *Malpighi*, and Dr. *Grew*, in the places cited in *note* (*f*) and (*g*).

(*l*) Of Bulbous, and a great many more, probably of the far greater number of perennial roots of herbs, as Arum, Rape-Crowfoot, &c. it is very obſervable, that their root is annually renewed, or repaired, out of the trunk or ſtalk itſelf; that is to ſay, the baſis of the ſtalk continually, and by inſenſible degrees, deſcending below the ſurface of the earth, and hiding itſelf therein, is thus both in nature, place, and office, changed into a true root. ---So in Brownwort, the baſis of the ſtalk ſinking down by degrees, till it lies under ground, becomes the upper part of the root; and continuing ſtill to ſink, the next year becomes the lower part; and the next after that, rots away; a new addition ſeed (*m*), or fruit, till invited out by the kindly warmth of the ſpring! And when the whole vegetable race is thus called out, it is very pretty to obſerve the methods of nature in guarding thoſe inſenſitive creatures againſt harms and inconveniencies, by making ſome (for inſtance) to lie down proſtrate, and others, to cloſe themſelves up (*n*) upon the touch of animals

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tion being ſtill yearly made out of the ſtalk, as the elder parts yearly rot away. Grew, *ibid. l.* 2. *p.* 59. *ubi plura vid.*

(*m*) How ſafe and agreeable a conſervatory the earth is to vegetables, more than any other, is manifeſt, from their rotting, drying, or being render'd infecund in the waters, or the air; but in the earth their vigour is long preſerved. Thus of ſeeds particularly, Mr. *Ray* thinks ſome may probably retain their fecundity for ten years, and others loſe it in five; but, ſaith he, ‘In terræ gremio latitantia, quamvis tot caloris, frigoris, humoris & ſiccitatis varietatibus ibidem obnoxia, diutiùs tamen (ut puto) fertilitatem ſuam tuentur quàm ab hominibus diligentiſſimè cuſtodita; nam & ego & alii ante me multi obſervârunt Sinapeos vim magnam enatam in aggeribus foſſarum recens factis inque areis gramineis effoſſis, ubi poſt hominum memoriam nulla unquam Sinapeos ſeges ſuccreverat. Quam tamen non ſpontè ortam ſuſpicor, ſed è ſeminibus in terrâ per tot annos reſiduis etiam prolificis.’ Ray, *Hiſt. Pl. l.* 1. *c.* 13.

(*n*) ‘Plantæ nonnullæ Æſchynomenæ Veteribus dictæ, Recentioribus Vivæ, & Senſitivæ, & Mimoſæ, haud obſcura ſenſûs indicia produnt; ſi-

‘quidem

animals, and the moſt to ſhut up their flowers, their down (*o*), or other their like guard, upon the cloſe and cool of the evening, by means of rain, or other matters that may be prejudicial to the tender ſeed.

And now to theſe conſiderations relating to the ſeed, I might add the various ways of nature in diſſipating and ſowing it, ſome being, for this end, winged with light down, or wings,

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'folia earum manu aut baculo tacta, & paululum 'compreſſa, pleno etiam meridie, ſplendente ſole, 'illico ſe contrahunt; in nonnullis etiam ſpeciebus cauliculi teneriores concidunt & velut marceſcunt; quid idem ab aëre frigidiore admiſſo 'patiuntur. Ray, *Hiſt. Pl. T.* 1. *l.* 18. *App.* §. 2. *c.* 2. *p.* 978.

(*o*) I have obſerved that many, if not moſt vegetables, do expand their flowers, down, &c. in warm, ſhun-ſhiny weather, and again cloſe them towards evening, or in rain, &c. eſpecially at the beginning of flowering, when the ſeed is young and tender; as is manifeſt in the down of Dandelion, and other downs; and eminently in the flowers of Pimpernel; the opening and ſhutting of which, are the countryman's weather-wiſer; whereby, *Gerard* ſaith, he foretelleth what weather ſhall follow the next day; 'For, ſaith he, if the flowers 'be cloſe ſhut up, it betokeneth rain and foul 'weather; contrarywiſe, if they be ſpread abroad, 'fair weather.' Ger. *Herb. B.* 2. *c.* 183.

'Eſt & alia [arbor in Tylis] ſimilis, folioſior tamen, roſeique floris; quem noctu comprimens, aperire incipit ſolis exortu, meridie expandit. In'colæ dormire eam dicunt.' Plin. *Nat. Hiſt. l.* 12. *c.* 11.

wings, to be conveyed about by the winds; others being laid in elaſtick, ſpringy cafes, that when they burſt and crack, dart their ſeed at convenient diſtances, performing thereby the part of a good huſbandman (*p*); others, by

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(*p*) ‘ So ſoon as the ſeed is ripe, Nature taketh ‘ ſeveral methods for its being duly ſown; not only in the opening of the Uterus, but alſo in the ‘ make of the ſeed itſelf. For, firſt, the ſeeds of ‘ many plants, which affect a peculiar ſoil or ſeat, ‘ as of Arum, Poppy, &c. are heavy and ſmall ‘ enough, without farther care, to fall directly ‘ down into the ground.-----But if they are ſo ‘ large and light, as to be expoſed to the wind, ‘ they are often furniſhed with one or more hooks, ‘ to ſtay them from ſtraying too far from their ‘ proper place.---So the ſeeds of Avens have one ‘ ſingle hook; thoſe of Agrimony and Gooſegraſs, ‘ many; both the former loving a warm bank; ‘ the latter, an hedge for its ſupport. On the ‘ contrary, many ſeeds are furniſhed with wings ‘ or feathers; partly with the help of the wind to ‘ carry them, when ripe, from off the plant, as ‘ of Aſh, &c.---and partly to enable them to make ‘ their flight more or leſs abroad, that ſo they may ‘ not, by falling together, come up too thick; and ‘ that if one ſhould miſs a good ſoil or bed, another may hit. So the kernels of Pine have wings ‘ ---yet ſhort----whereby they fly not into the air, ‘ but only flutter upon the ground. But thoſe of ‘ Typha, Dandelion, and moſt of the pappous ‘ kind---have long numerous feathers, by which ‘ they are wafted every way.---Again, there are ‘ ſeeds which are ſcatter’d, not by flying abroad, ‘ but by their agreeable taſte and ſmell, and ſalutary nature,

‘but by being either ſpirted or flung away. The firſt of thoſe are Wood-ſorrel, which having a running root, Nature ſees fit to ſow the ſeeds at ſome diſtance. The doing of which is affected by a white ſturdy cover, of a tendinous or ſpringy nature.---This cover, ſo ſoon as it begins to dry, burſts open on one ſide, in an inſtant, and is violently turn'd inſide outward---and ſo ſmartly throws off the ſeed. The ſeed of Harts-tongue is flung or ſhot away---by the curious contrivance of the ſeed-caſe, as in Codded Arſmart, only there the ſpring moves and curls inward, but here outward; viz. Every ſeed-caſe--is of a ſpheric figure, and girded about with a ſturdy ſpring.---The ſurface of the ſpring reſembles a fine ſkrew.----So ſoon as---this ſpring is become ſtark enough, it ſuddenly breaks the caſe into two halves, like two little cups, and ſo flings the ſeed.’ Grew, *ib. p.* 199. and in *tab.* 72. all theſe admirable artifices are handſomly repreſented.

‘Quin ſi quantitas modica ſeminum (Filicis Phyllitidis quoque) à foliis in ſubjectam chartæ mundæ----ſchedam decutiatur, detergatúrve, & deinde in acervum converratur, veſicularum ſeminalium plurimis unà diſſilientibus, & ſibi invicem alliſis, acervulus variè moveri per partes videbitur, non ſecus ac ſi Syrenibus aut iſtiuſmodi beſtiolis repletus eſſet---quin ſi locus tranquillus ſit, aure proximè admotâ, crepitantium inter rumpendum vaſculorum ſonitus----percipietur; & ſi microſcopio chartam oculis oberres, ſemina per eam undique ſparſa, & ad notabilem ab acervo diſtantiam projecta comperies.’ Ray, *ibid. p.* 132.

‘The

nature, inviting themſelves to be ſwallowed,
and

‘ The admirable contrivance of Nature in this ‘ plant, is moſt plain: For the ſeed-veſſels being ‘ the beſt preſerver of the ſeed, ’tis there kept from ‘ the injuries of air and earth, till it be rainy, ‘ when it is a proper time for it to grow, and ‘ then it is thrown round the earth, as grain by a ‘ ſkilful ſower.----When any wet touches the end ‘ of the ſeed-veſſels, with a ſmart noiſe and ſud‘den leap it opens itſelf, and with a ſpring ſcat‘ters its ſeed to a pretty diſtance round it, where ‘ it grows.’ *Dr.* Sloane *Voy. to* Jamaica, *p.* 150. *of the Gentianella flore cæruleo, &c. or Spirit-leaf.*

The plants of the Cardamime-family, and many others, may be added here, whoſe cods fly open, and dart out their ſeed, upon a ſmall touch of the hand. But the moſt remarkable inſtance is in the Cardamime impatiens, ‘ cujus Siliquæ [ſaith Mr. ‘ *Ray*] vel leviter tactæ, actutùm ejaculantur [Se‘mina] imò quod longè mirabilius videtur, etſi ‘ ſiliquas non tètigeris, ſi tamen manum velut ‘ tacturus proximè admoveas, ſemina in appro‘pinquantem evibrabunt; quod tum Moriſonus ſe ‘ ſæpius expertum ſcribit, tum Johnſtonus apud ‘ Gerardum verum eſſe affirmat.’ *Hiſt. Plant. l.* 16. *c.* 20.

Neither is this proviſion made only for land-vegetables, but for ſuch alſo as grow in the ſea. Of which I ſhall give an inſtance from my before-commended friend Dr. *Sloane.* ‘ As to the Fuci,-- ‘ their ſeed hath been diſcovered (and ſhew’d me ‘ firſt) by the induſtry of the ingenious herbariſt ‘ Mr. *Sam. Doody,* who found on many of this ‘ kind ſolid tubercules, or riſings, in ſome ſeaſons, ‘ wherein were lodged ſeveral round ſeeds, as big and carried about by the birds, and thereby alſo fertilized, by paſſing through their bodies;

'as Muſtard-ſeed, which, when ripe, the outward
'membrane of the tubercule breaking, leaveth the
'ſeed to float up and down with the waves. The
'ſeed coming near ſtones, or any ſolid foundation,
'by means of a mucilage it carries with it, ſticks
'to them, and ſhoots forth Ligulæ with branches,
'and in time comes to its perfection and magni-
'tude." Sloan. *Voyag. Jamaica, p.* 50.

But although Mr. *Doody* had hinted, and conjectured at the thing, yet the firſt that diſcovered the ſeeds in Fuci, was the before-commended Dr. *Tancred Robinſon*; as may be ſeen by comparing what Mr. *Ray* ſaith in his *Synopſ. Stirp. Brit. p.* 6. with his *Append. Hiſt. p.* 1849. Beſides which Fuci, the Doctor tells me, he obſerved veſſels and ſeed in Carolloid Shrubs, as alſo in ſeveral Fungi, not only in the ſpecies of Crepitus Lupi, but alſo between the Lamellæ of other ſpecies, and in that ſubterraneous kind called Truffles, whoſe ſeed and veſſels open in the Cortex, at ſome ſeaſons, he ſaith, like that of Mallows in ſhape.

As to the Crepitus Lupi, I have more than once examined their powder, with thoſe excellent microſcopes of Mr. *Wilſon*'s make: But the moſt ſatisfactory view Mr. *Wilſon* himſelf gave me; by which I found the ſeeds to be ſo many exceeding ſmall puff-balls, with round heads, and longer than ordinary ſharp-pointed ſtalks, as if made on purpoſe to prick eaſily into the ground. Theſe ſeeds are intermixed with much duſty matter, and become hurtful to the eyes, probably by their ſharp ſtalks pricking and wounding that tender organ.

dies (*q*); and others not thus taken care of, do many of them, by their uſefulneſs in human life, invite the huſbandman and gardener carefully to ſow and nurſe them up.

(*q*) The ancient naturaliſts do generally agree, that Miſſeltoe is propagated by its Seeds carried about by, and paſſing through the body of birds. Thus *Theophraſtus de Cauſ. Plant. l.* 2. *c.* 24. Τὸ δὲ ἀπὸ τῆς ὀρνίθων, &c. ‘ Initium verò à paſtu avium: ‘ ----Quippe Viſco detracto confectoque in alveis, ‘ quod frigidiſſimum eſt, ſemen cum excremento ‘ purum dimittitur, & factâ mutatione aliquâ in ‘ arbore Stercoris cauſâ pullulat, erumpitque, &c.’ So alſo *Pliny* ſaith; viz. ‘ Omnino autem ſatum ‘ [Viſcum] nullo modo naſcitur, nec niſi per alvum Avium redditum, maximè Palumbis ac Turdi. Hæc eſt natura, ut niſi maturatum in ventre ‘ Avium, non proveniat.’ Plin. *Nat. Hiſt. l.* 16. *c.* 44. Whether what *Theophraſtus* and *Pliny* affirm, be conducive to the better fertilizing the ſeeds of Miſſeltoe, I know not; but that it is not of abſolute neceſſity, I can affirm upon mine own experience, having ſeen the ſeeds germinate, even in the bark of Oak. But although they ſhot above an inch, and ſeem'd to root in the tree, yet they came to nothing, whether deſtroy'd by Ants, &c. which I ſuſpected, or whether diſagreeing with the Oak, I know not. But I ſince find the matter put out of doubt by Mr. *Doody*; which ſee in Mr. *Ray*'s *Hiſt. Plant. App. p.* 1918.

Nutmegs are ſaid to be fertilized after the ſame manner, as *Tavernier* ſaith was confirmed to him by perſons that lived many years in thoſe parts; whoſe relation was: The Nutmeg being ripe, ſeveral

To this ſo ſingular a care about the propagation and conſervation of the ſpecies of vegetables,

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veral birds come from the iſlands toward the South, and devour it whole, but are forced to throw it up again, before it be digeſted: And that the Nutmeg, then beſmear'd with a viſcous matter, falling to the ground, takes root, and produces a tree, which would never thrive, was it planted. Tavern. *of the Commod. of the Great Mogul.* And M. *Thevenot*, in his travels to the *Indies*, gives this account: The tree is produced after this manner; there is a kind of birds in the iſland, that having pick'd off the green huſk, ſwallow the nuts, which having been ſome time in their ſtomach, they void by the ordinary way; and they fail not to take rooting in the place where they fall, and in time grow up to a tree. This bird is ſhaped like a Cuckow; and the Dutch prohibit their ſubjects, under pain of death, to kill any of them. *Vide* Sir T. Pope-Blunt's *Nat. Hiſt.*

But Mr. *Ray* gives a ſomewhat different account: 'Hunc fructum [Nucem Moſchatam] variæ quidem 'aves depaſcuntur, ſed maximè Columbæ genus 'album & parvum, quæ dehiſcente nucamento, il'lectæ ſuavitate macis, hunc cum nuce eripiunt & 'devorant, nec niſi repletâ ingluvie capaciſſimâ ſa'ginam deſerunt. Noſtrates ibi mercatores co'lumbis iſtis *Nut-eaters*, ſive Nucivoris nomen im'poſuerunt. Quas autem vorant nuces, poſt inte'gras per alvum reddunt. Redditæ citiùs deinde 'germinant utpote præmaceratæ fervore ventri'culi. Arbores inde natæ ceu præcociores, facilè 'ſunt corruptioni obnoxiæ fructumque ferunt cæte'ris multo viliorem, & hâc causâ neglectum inco'lis contemtumque, præter Macin, quem ad adul'terandum meliorem adhibent.' Ray, *Hiſt. Pl. l.* 27. *c.* 4.

getables, I might add the nice proviſion that is made for their ſupport and aid, in ſtanding and growing, that they may keep their heads above ground, and not be rotted and ſpoiled in the earth themſelves, nor thereby annoy us; but, on the contrary, miniſter to all their ends, and our uſes; to afford us houſes, utenſils, food (*r*), phyſick, cloathing, yea, diverſion too, by the beauty of their looks, by the fragrancy of their ſmell, by creating us pleaſant ſhades againſt the ſcorching beams of ſummer, and ſkreening us againſt the piercing winds, and cold of winter (*s*).

(*r*) ‘Arbores blandioribus fruge ſuccis hominem mitigavere. Ex iis recreans membra Olei liquor, vireſque potus Vini; tot denique ſapores annui ſponte venientes: & menſæ, depugnetur licèt earum cauſa cum feris, & paſti naufragorum corporibus piſces expetantur, etiamnum tamen ſecundæ. Mille præterea ſunt uſus earum, ſine quibus vita degi non poſſit. Arbore ſulcamus maria, terraſque admovemus, arbore exædificamus tecta.’ Plin. *Nat. Hiſt. l.* 12. *c.* 1.

(*s*) ‘Plantarum Uſus latiſſimè patet, & in omni vitæ parte occurrit. Sine illis lautè, ſine illis commodè non vivitur, at nec vivitur omnino: Quæcunque ad victum neceſſaria ſunt, quæcunque ad delicias faciunt, è locupletiſſimo ſuo penu abundè ſubminiſtrant. Quanto ex iis menſa innocentior, mundior, ſalubrior quàm ex animalium cæde & lanienâ? Homo certè naturâ animal carnivorum non eſt; nullis ad prædam & rapinam armis inſtructum, non dentibus exertis & ſerratis, non unguibus aduncis. Manus ad fruc-

And it is very obſervable what admirable proviſions are made for this purpoſe of their ſupport and ſtanding, both in ſuch as ſtand by their own ſtrength, and ſuch as need the help of others. In ſuch as ſtand by their own ſtrength, it is by means of the ſtronger and more ligneous parts (equivalent to the bones in animals) being made not inflexible, as bones; becauſe they would then be apt to break; but of a yielding elaſtick nature, to eſcape and dodge the violence of the winds; and by means alſo of the branches ſpreading handſomly and commodiouſly about, at an angle of about 45 *gr.* by which means they equally fill up, and at the ſame time make an æquilibration of the top (*t*). And

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tus colligendos, dentes ad mandendos comparati. Non legimus ei ante Diluvium carnes ad eſum conceſſas. At non victum tantùm nobis ſuppeditant, ſed & veſtitum, & medicinam & domicilia aliaque ædificia & navigia, & ſupellectilem, & focum, & oblectamenta ſenſuum animique: Ex his naribus odoramenta & ſuffumigia parantur. Horum flores inenarrabili colorum & ſchematum varietate, & elegantiâ, oculos exhilarant, ſuaviſſimâ odorum quos expirant fragrantiâ ſpiritus recreant. Horum fructus gulæ illecebræ menſas ſecundas inſtruunt, & languentem appetitum excitant. Taceo virorem amœniſſimum oculis amicum, quem per prata, paſcua, agros, ſylvas ſpatiantibus objiciunt, & umbras quas contra æſtum & ſolis ardores præbent.' Ray, *ib. l.* 1. *c.* 24. *p.* 46.

(*t*) All vegetables of a tall and ſpreading growth, ſeem to have a natural tendency to a hemiſpherical

And as for ſuch vegetables as are weak, and not able to ſupport themſelves, 'tis a wonderful faculty they have, ſo readily and naturally to make uſe of the help of their neighbours, embracing and climbing up upon them (*u*), and

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cal dilatation, but generally confine their ſpreading within an angle of 90 *gr.* as being the moſt becoming and uſeful diſpoſition of its parts and branches. Now the ſhorteſt way to give a moſt graceful and uſeful filling to that ſpace of dilating and ſpreading out, is to proceed in ſtrait lines, and to diſpoſe of thoſe lines, in a variety of parallels, &c. And to do that in a quadrantal ſpace, &c. there appears but one way poſſible, and that is, to form all the interſections, which the ſhoots and branches make, with angles of 45 *gr.* only. And I dare appeal to all, if it be not in this manner, almoſt to a nicety obſerved by nature, &c. A viſible argument, that the plaſtick capacities of matter are governed and diſpoſed by an all-wiſe and infinite Agent, the native ſtrictneſſes and regularities of them plainly ſhewing from whoſe hand they come. *Account of the Origin and Format. of Foſſ. Shells, &c. Print. Lond.* 1705. *p.* 38, 41.

(*u*) 'In Hederâ, ſurculi & rami hinc inde claviculos, quaſi radiculas emittunt, quæ parietibus, vel occurrentibus arboribus veluti digitis firmantur, & in altum ſuſpenduntur. Hujuſmodi radiculæ ſubrotundæ ſunt, & pilis cooperiuntur; & quod mirum eſt, glutinoſum fundunt humorem, ſeu Terebinthinam, quâ arctè lapidibus nectuntur & agglutinantur.------Non minori induſtriâ natura utitur in vite Canadenſi, &c.' The admirable and curious make of whoſe tendrels and

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and uſing them as crutches to their feeble bodies: ſome by their odd convolving faculty, by twiſting themſelves like a ſcrew about others; ſome advancing themſelves, by catching and holding with their curious claſpers and tendrels, equivalent to the hands; ſome by ſtriking in their rooty feet; and others by the emiſſion of a natural glue, cloſely and firmly

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their feet, ſee in the illuſtrious author, *Malpig. de capreolis, &c. p.* 48.

Claſpers are of a compound nature, between that of a root and a trunk. Their uſe is ſometimes for ſupport only; as in the Claſpers of Vines, Briony, &c. whoſe branches being long, ſlender, and fragile, would fall by their own weight, and that of their fruit; but theſe claſpers taking hold of any thing that is at hand, which they do by a natural circumvolution which they have (thoſe of Briony have a retrogade motion about every third circle, in the form of a double Claſp; ſo that if they miſs one way, they may catch the other.) Sometimes the uſe of Claſpers is alſo for a ſupply, as in the trunk-roots of Ivy; which being a plant that mounts very high, and being of a cloſer and more compact ſubſtance than that of Vines, the ſap would not be ſufficiently ſupplied to the upper ſprouts, unleſs theſe aſſiſted the mother-root; but theſe ſerve alſo for ſupport too. Sometimes alſo they ſerve for ſtabiliment, propagation, and ſhade; for the firſt of theſe ſerve the Claſpers of Cucumbers; for the ſecond, thoſe, or rather the trunk-roots of Chamomil; and for all three the trunk-roots of Strawberries. Harris *Lex. Tech. in verb. Claſpers.*

firmly adhering to ſomething or other that adminiſters ſufficient ſupport unto them. All which various methods being ſo nicely accommodated to the indigencies of thoſe helpleſs vegetables, and not to be met with in any beſides, is a manifeſt indication of their being the contrivance and work of the Creator, and that his infinite wiſdom and care condeſcends, even to the ſervice, and well-being of the meaneſt, moſt weak, and helpleſs inſenſitive parts of the creation.

In the laſt place, to the uſes already hinted at, I might add a large catalogue of ſuch among vegetables as are of peculiar uſe and ſervice to the world, and ſeem to be deſign'd as 'twere on purpoſe, by the moſt merciful Creator, for the good of man, or other creatures (*w*). Among grain, I might name the great fertility (*x*) of ſuch as ſerves for bread, the eaſy culture and propagation thereof, and the agreement of every ſoil and climate to it. Among trees and plants, I might inſtance in ſome

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(*w*) Vegetables afford not only food to irrationals, but alſo phyſick, if it be true which *Ariſtotle* ſaith, and after him *Pliny*; which latter, in his 8th *book*, *chap.* 27. ſpecifies divers plants made uſe of as ſpecificks, by divers, both beaſts and birds; As Dittany by wounded Deer; Celandine by Swallows, to cure the ſore eyes of their young, &c. And if the reader hath a mind to ſee more inſtances of this nature (many of them fanciful enough) he may conſult *Merſenne in Geneſ. p.* 933.

(*x*) See before, *book* iv. *chap.* 11. *note* (*b*).

ſome that ſeem to be deſign'd, as 'twere, on purpoſe, for almoſt every uſe (*y*), and convenience;

(*y*) 'Planta hæc unica [Aloe Americana] inquit Fr. Hernandez, quicquid vitæ eſſe poteſt neceſſarium præſtare facilè poteſt, ſi eſſet rebus humanis modus. Tota enim illa lignorum ſepiendorumque agrorum uſum præſtat, caules tignorum, folia verò tecta tegendi imbricum, lancium: eorundem nervuli, & fibræ eundem habent uſum ad linteamina, calceos, & veſtimenta conficienda, quem apud nos Linum, Cannabis, Goſſipium, E mucronibus fiunt clavi, aculei, ſubulæ, quibus perforandis auribus, macerandi corporis gratiâ, Indis uti mos erat cùm Dæmonum vacarent cultui; item aciculæ, acus, tribuli militares & raſtilla idonea pectendis ſubtegminibus. Præterea è ſucco mananti, cujus evulſis germinibus internis foliiſve tenerioribus cultis [Yztlinis] in mediam cavitatem, ſtillat planta, unica ad 50 interdum amphoras (quod dictu eſt mirabile) Vina, Mel, Acetum ac Saccharum parantur.' [The methods of which he tells] 'Idem ſuccus menſes ciet, alvum lenit, Urinam evocat, Renes & Veſicam emundat. E radice quoque Reſtes fiunt firmiſſimæ. Craſſiores foliorum partes, truncuſque, decocta ſub terrâ, edendo ſunt apta, ſapiuntque Citrea fruſta ſaccharo condita: quin & vulnera recentia mirè conglutinant.------Folia quoque aſſa & affecto loco impoſita convulſionem curant, ac dolores leniunt (præcipuè ſi ſuccus ipſe calens bibatur) quamvis ab Indicâ proficiſcantur lue, ſenſum hebetant, atque torporem inducunt. Radicis ſuccus Luem Veneream curat apud Indos, ut Dr. *Palmer*.' Ray, *ibid. l.* 21. *c.* 7. See alſo Dr. *Sloane*'s Voyage to *Jamaica*, *p.* 247.

venience; ſome to heal the moſt ſtubborn and dangerous diſtempers (*z*), to alleviate and eaſe the pains (*aa*) of our poor infirm bodies, all the

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There are alſo two ſorts of Aloe beſides, mentioned by the ſame Dr. *Sloane*, one of which is made uſe of for fiſhing-lines, bow-ſtrings, ſtockings and hammocks. Another hath leaves that hold rain-water, to which travellers, &c. reſort to quench their thirſt, in ſcarcity of wells, or waters, in thoſe dry countries. *Ibid. p.* 249.

(*z*) For inſtance here, I ſhall name the Cortex Peruvianus, which Dr. *Morton* calls ‘Antidotus in levamen ærumnarum vitæ humanæ plurimarum divinitùs conceſſa.’ *De* Febr. *Exer. v. c.* 3. ‘In Sanitatem Gentium proculdubio à Deo O. M. conditus. Cujus gratiâ, Arbor vitæ, ſiqua alia, jure merito apellari poteſt.’ *Id. ib. c.* 7. ‘Eheu! quot conviciis Herculea & divina hæc Antidotus jactabatur?’ *Ibid.*

To this (if we may believe the *Epher. German. Ann.* 12. *Obſer.* 74. and ſome other authors) we may add Trifolium Paludoſum, which is become the Panacea of the *German* and Northern Nations.

(*aa*) ‘Pro doloribus quibuſcunque ſedandis præſtantiſſimi ſemper uſus Opium habetur; quamobrem meritò Nepenthe appellari ſolet, & remedium verè divinum exiſtit. Et quidem ſatis mirari vix poſſumus, quomodo urgente viſceris aut membri cujuſpiam torturâ inſigni, & intolerabili cruciatu, pharmacum hoc, incantamenti inſtar, levamen & ἀναλγησίαν ſubitam, immò interdum abſque ſomno, aut ſaltem priùs quàm advenerit, concedit. Porrò adhuc magis ſtupendum eſt, quod donec particulæ Opiaticæ operari, & potentiam

the world over: and ſome deſigned for the peculiar ſervice and good of peculiar places, either to cure ſuch diſtempers as are peculiar to them, by growing more plentifully there than elſewhere (*bb*); or elſe to obviate ſome inconvenience there; or to ſupply ſome conſtant neceſſity, or occaſion not poſſible, or at leaſt not eaſy, to be ſupplied any other way (*cc*). It is, for inſtance, an admirable proviſion

'tiam ſuam narcoticam exerere continuant, immo 'etiam aliquamdiu poſtquam ſomnus finitur, ſumma alleviatio, & indolentia in parte affectâ perſiſtit.' Willis, *Phar. Rat. Par.* 1. §. 7. *cap.* 1. §. 15.

(*bb*) 'Tales Plantarum ſpecies in quacunque regione à Deo creantur quales hominibus & animalibus ibidem natis maximè conveniunt; imò ex plantarum naſcentium frequentiâ ſe fere animadvertere poſſe quibus morbis [endemiis] quælibet regio ſubjecta ſit, ſcribit Solenander. Sic apud Danos, Friſios, Hollandos, quibus Scorbutus frequens, Cochlearia copioſè provenit.' Raii *Hiſt. Plan. lib.* 16. *c.* 3.

To this may be added, *Elſner*'s obſervations concerning the virtues of divers things, in his obſervations *de Vincetoxico Scrophularum remedio. F. Germ. T.* 1. *Obſ.* 57.

John Benorovinus, a phyſician of *Dort*, may be here conſulted, who wrote a book on purpoſe to ſhew, that every country hath every thing ſerving to its occaſions, and particularly remedies afforded to all the diſtempers it is ſubject unto. See *Benor.* Αὐτάρκεια *Batav. ſive Introd. ad Medic. indigenam.*

(*cc*) The deſcription Dr. *Sloane* gives of the Wild Pine is, that its leaves are channelled, fit to catch and proviſion made for ſome countries ſubject to drought, that when the waters every where fail, there are vegetables which contain not only moiſture enough to ſupply their own ve-

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and convey water down into their reſervatories; that theſe reſervatories are ſo made, as to hold much water, and cloſe at top when full, to hinder its evaporation; that theſe plants grow on the arms of the trees in the woods every where [in thoſe parts], as alſo on the barks of their trunks. And one contrivance of Nature in this vegetable, he ſaith, is very admirable. The ſeed hath long and many threads of Tomentum, not only that it may be carried every where by the wind---but alſo, that it may by thoſe threads, when driven through the boughs, be held faſt, and ſtick to the arms, and exterior parts of the barks of trees. So ſoon as it ſprouts or germinates, although it be on the under part of a bough,---its leaves and ſtalk riſe perpendicular, or ſtrait up, becauſe if it had any other poſition, the ciſtern (beforementioned, by which it is chiefly nouriſhed---) made of the hollow leaves, could not hold water, which is neceſſary for the nouriſhment and life of the plant.---In ſcarcity of water, this reſervatory is neceſſary and ſufficient, not only for the plant itſelf, but likewiſe is very uſeful to men, birds, and all ſorts of inſects, whither they come in troops, and ſeldom go away without refreſhment. *Id. ib. p.* 188. and *Philoſ. Tranſact.* N°. 251. where a figure of this notable plant, as alſo in *Lowthorp*'s *Abridg. vol.* II. *p.* 669.

The Wild Pine, ſo called, &c. hath leaves that will hold a pint and a half, or quart of rain-water;

getation and wants, but afford drink alſo both to man and other creatures, in their great extremities (*dd*); and a great deal more might be inſtanced in of a like nature, and things that

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and this water refreſhes the leaves, and nouriſhes the root. When we find theſe pines, we ſtick our knives into the leaves, juſt above the root, and that lets out the water, which we catch in our hats, as I have done many times, to my great relief. Dampier's *Voy. to* Campeachy, *ch.* 2. *p.* 56.

(*dd*) *Navarette* tells us of a tree called the Bejuco, which twines about other trees, with its end hanging downwards; and that travellers cut the nib off it, and preſently a ſpout of water runs out from it, as clear as cryſtal, enough, and to ſpare, for ſix or eight men. I drank, ſaith he, to my ſatisfaction of it, found it cool and ſweet, and would drink it as often as I found it in my way. It is a juice and natural water. It is the common relief of the herdſmen on the mountains; when they are thirſty, they lay hold on the Bejuco, and drink their fill. *Collect. of Voy. and Trav. vol.* I. *in the Suppl. to* Navarette's *Account of* China, *p.* 355.

The Water-with of *Jamaica* hath the ſame uſes; concerning which, my before-commended friend, Dr. *Sloane*, favoured me with this account from his original papers: ‘ This Vine growing on dry hills, ‘ in the woods, where no water is to be met with, ‘ its trunk, if cut into pieces two or three yards ‘ long, and held by either end to the mouth, af‘ fords ſo plentifully a limpid, innocent, and re‘ freſhing water, or ſap, as gives new life to the ‘ droughty traveller or hunter. Whence this is ‘ very much celebrated by all the inhabitants of ‘ thoſe that bear ſuch plain impreſſes of the divine wiſdom and care, that they manifeſt the ſuper-intendence of the infinite Creator.

Thus I have given a ſketch of another branch of the creation, which (although one of the meaneſt, yet) if it was accurately viewed, would abundantly manifeſt itſelf to be the work of God. But becauſe I have been ſo long upon the other parts, although leſs than they deſerve, I muſt therefore content myſelf with thoſe general hints I have given; which may however ſerve as ſpecimens of what might have been more largely ſaid about this inferior part of the animated creation.

As to the inanimate part, ſuch as ſtones, minerals, earth, and ſuch-like, that which I have already ſaid in the beginning ſhall ſuffice.

‘ thoſe iſlands, as an immediate gift of Providence
‘ to their diſtreſſed condition.’

To this we may add what Mr. *Ray* takes notice of concerning the Birch-tree. ‘ In initiis veris ‘ antequam folia prodiere, vulnerata dulcem ſuc‘ cum copioſè effundit, quem ſiti preſſi paſtores in ‘ ſylvis ſæpenumerò potare ſolent. Nos etiam non ‘ ſemel eo liquore recreati ſumus, cùm herbarum ‘ gratiâ vaſtas peragravimus ſylvas, inquit Tragus.’ Raii *Cat. Plant. circa Cantab. in Betula.*

BOOK XI.

Practical Inferences from the foregoing SURVEY.

HAVING in the preceding Books carried my ſurvey as far as I care at preſent to engage myſelf, all that remaineth, is to draw ſome inferences from the foregoing ſcene of the great Creator's works, and ſo conclude this part of my intended work.

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CHAP. I.

That God's works are great and excellent.

THE firſt Inference I ſhall make, ſhall be by way of confirmation of the text, That 'the works of the Lord are great (*a*).' And this is neceſſary to be obſerved, not againſt

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(*a*) 'Equidem ne laudare quidem ſatis pro merito poſſum ejus ſapientiam ac potentiam, qui animalia fabricatus eſt. Nam ejuſmodi opera non laudibus modò, verùm etiam hymnis ſunt majora, quæ priuſquam inſpexiſſemus, fieri non poſſe perſuaſum habeamus, conſpicati verò, falſos nos opinione fuiſſe comperimus.' Galen. *de uſu part.* *l.* 7. *c.* 15.

againſt the Atheiſts only, but all other careleſs, incurious obſervers of God's works. Many of our uſeful labours, and ſome of our beſt modern books, ſhall be condemned with only this note of reproach, That they are about trivial matters (*b*), when in truth they are ingenious and noble diſcoveries of the works of God. And how often will many own the world in general to be a manifeſtation of the infinite Creator, but look upon the ſeveral parts thereof as only toys and trifles, ſcarce deſerving their regard? But in the foregoing (I may call it) tranſient view I have given of this lower, and moſt ſlighted part of the Creation, I have, I hope, abundantly made out, that all the works of the Lord, from the moſt regarded, admired, and praiſed, to the meaneſt and moſt ſlighted, are great and glorious works, incomparably contrived, and as admirably made, fitted up, and placed in the world. So far then are any of the works of the Lord (even thoſe eſteemed the meaneſt) from deſerving to be diſregarded, or contemned by us (*c*), that on the contrary they deſerve

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(*b*) 'Non tamen pigere debet lectores, ea intelligere, quemadmodum ne naturam quidem piguit ea reipsâ efficere.' Galen. *ibid. l.* 11. *fin.*

(*c*) 'An igitur etiamſi quemadmodum natura hæc, & ejuſmodi, ſummâ ratione ac providentiâ agere potuit, ita & nos imitari aliquando poſſemus? Ego verò exiſtimo multos noſtrûm ne id quidem poſſe, neque enim artem naturæ exponunt;

deſerve (as ſhall be ſhewn in the next chapter) to be ſought out, enquired after, and curiouſly and diligently pried into by us; as I have ſhewed the word in the text implies.

' nunt: Eo enim modo omnino eam admirarentur, ' ſin minùs, eam ſaltem non vituperarent.' Galen. *ibid. l.* 10. *c.* 3.

CHAP. II.

That God's Works ought to be enquired into, and that ſuch Enquiries are commendable.

THE Creator doubtleſs did not beſtow ſo much curioſity, and exquiſite workmanſhip and ſkill upon his creatures, to be looked upon with a careleſs incurious eye, eſpecially to have them ſlighted or contemned; but to be admired by the rational part of the world, to magnify his own power, wiſdom, and goodneſs throughout all the world, and the ages thereof. And therefore we may look upon it as a great error, not to anſwer thoſe ends of the infinite Creator, but rather to oppoſe and affront them. On the contrary, my text commends God's works, not only for being great, but alſo approves of thoſe curious and ingenious enquirers that ſeek them out, or pry into them. And the more we pry into, and diſcover of them, the greater and more glorious we find them to be, the more worthy of, and the more expreſly to proclaim their great Creator. Com-

Commendable then are the reſearches which many amongſt us have, of late years, made into the works of nature, more than hath been done in ſome ages before. And therefore when we are aſked, *cui bono?* To what purpoſe ſuch enquiries, ſuch pains, ſuch expence? the anſwer is eaſy, It is to anſwer the ends for which God beſtowed ſo much art, wiſdom and power about them, as well as given us ſenſes to view and ſurvey them; and an underſtanding and curioſity to ſearch into them: It is to follow and trace him, when and whither he leads us, that we may ſee and admire his handy-work ourſelves, and ſet it forth to others, that they may ſee, admire, and praiſe it alſo. I ſhall then conclude this inference with what Elihu recommends, *Job* xxxvi. 24, 25. 'Remember that thou magnify his 'work, which men behold. Every man may 'ſee it, man may behold it afar off.'

CHAP. III.

That God's Works are manifeſt to all: whence the unreaſonableneſs of Infidelity.

THE concluding words of the preceding chapter ſuggeſt a third inference, that the works of God are ſo viſible to all the world, and withal ſuch manifeſt indications of the being and attributes of the infinite Creator, that they plainly argue the vileneſs and

and perverſeneſs of the Atheiſt, and leave him inexcuſable. For it is a ſign a man is a wilful, perverſe Atheiſt, that will impute ſo glorious a work as the Creation is, to any thing, yea a mere nothing (as chance is) rather than to God (*a*). It is a ſign the man is wilfully blind, that he is under the power of the devil, under the government of prejudice, luſt, and paſſion, not right reaſon, that will not diſcern what 'every one can ſee, what every man may behold afar off,' even the exiſtence and attributes of the Creator from his works. For as 'there is no ſpeech or language where their 'voice is not heard, their line is gone out 'through all the earth, and their words to 'the end of the world:' So all, even the barbarous

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(*a*) *Galen* having taken notice of the neat diſtribution of the nerves to the muſcles, and other parts of the face, cries out, 'Hæc enim fortunæ 'ſunt opera! Cæterùm tum omnibus [partibus] 'immitti, tantoſque eſſe ſingulos [nervos] magnitudine, quanta particulæ erat neceſſe; haud ſcio 'an hominum ſit ſobriorum ad fortunam opificem 'id revocare. Alioqui quid tandem erit, quod 'cum providentiâ & arte efficitur? Omnino enim 'hoc ei contrarium eſſe debet, quod caſu ac fortuitò fit.' And afterwards, 'Hæc quidem atque 'ejuſmodi artis ſcil. ac ſapientiæ opera eſſe dicemus, ſi modò fortunæ tribuenda ſunt quæ ſunt 'contraria; fietque jam quod in proverbiis---- 'Fluvii ſurſum fluent; ſi opera quæ nullum habent 'ornamentum neque rationem, neque modum artis eſſe; contraria verò fortunæ duxerimus, &c.' Galen *ubi ſupra, l.* 11. *c.* 7.

barbarous nations, that never heard of God, have from theſe his works inferred the exiſtence of a deity, and paid their homages to ſome deity, although they have been under great miſtakes in their notions and concluſions about him. But however, this ſhews how naturally and univerſally all mankind agree, in deducing their belief of a God from the contemplation of his works, or as even Epicurus himſelf in Tully (*b*) ſaith, from 'a 'notion that nature itſelf hath imprinted upon 'the minds of men. For, ſaith he, what na'tion is there, or what kind of men, that 'without any teaching or inſtructions, have 'not a kind of anticipation, or preconceived 'notion of a Deity?

An Atheiſt therefore (if ever there was any ſuch) may juſtly be eſteemed a monſter among rational beings; a thing hard to be met with in the whole tribe of mankind; an oppoſer of all the world (*c*); a rebel againſt human na-ture

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(*b*) 'Primùm eſſe Deos, quod in omnium ani'mis, &c.' And a little after, 'Cùm enim non 'inſtituto aliquo, aut more, aut lege ſit opinio 'conſtituta, maneatque ad unum omnium firma 'conſenſio, intelligi neceſſe eſt, eſſe Deos, quoniam 'inſitas eorum, vel potiùs innatas cognitiones, 'habemus. De quo autem omnium Natura con'ſentit, id verum eſſe neceſſe eſt. Eſſe igitur 'Deos confitendum eſt.' Cic. *de Nat. Deor. l.* 1. *c.* 16, 17.

(*c*) The Atheiſt in denying a God, doth, as *Plutarch* ſaith, endeavour----'Immobilia movere, '&

ture and reaſon, as well as againſt his God.

But above all, monſtrous is this, or would be, in ſuch as have heard of God, who have had the benefit of the clear goſpel-revelation. And ſtill more monſtrous this would be, in one born and baptized in the chriſtian church, that had ſtudied nature, and pried farther than others into God's works. For ſuch an one (if it be poſſible for ſuch to be) to deny the exiſtence, or any of the attributes of God, would be a great argument of the infinite inconvenience of thoſe ſins of intemperance, luſt, and riot, that have made the man abandon his reaſon, his ſenſes, yea, I had almoſt ſaid his very human nature (*d*), to engage him thus to deny the being of God.

So alſo it is much the ſame monſtrous infidelity, at leaſt betrays the ſame atheiſtical mind, to deny God's providence, care, and government of the world, or which is a ſpawn of the ſame Epicurean principles) to deny Final Cauſes (*e*) in God's works of creation; or

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'& bellum inferre non tantùm longo tempori, ſed
'& multis hominibus, gentibus, & familiis, quas
'religioſus Deorum cultus, quaſi divino furore cor-
'reptas, tenuit.' Plutar. *de Iſide*.

(*d*) See before, *note* (*b*).

(*e*) *Galen* having ſubſtantially refuted the *Epicurean* principles of *Aſclepiades*, by ſhewing his ignorance in anatomy and philoſophy, and by demonſtrating all the cauſes to be evidently in the works of Nature, viz. Final, efficient, inſtrumental, material, or with the profane, in *Pſal.* lxxiii. 11. to ſay, 'How doth God know? And is there knowledge in the moſt high?' For, as the witty and eloquent Salvian ſaith (*f*), 'They that 'affirm, nothing is ſeen by God, will, in all 'probability, take away the ſubſtance, as well 'as ſight of God.— But what ſo great madeneſs, ſaith he, as that when a man doth not 'deny God to be the creator of all things, 'he ſhould deny him to be the governor 'of them? or when he confeſſeth him to 'be the maker, he ſhould ſay, God neg'lecteth what he hath ſo made.

terial, and formal Cauſes; concludes thus againſt his fortuitous atoms, 'Ex quibus intelligi poteſt: 'Conditorem noſtrum in formandis particulis 'unum hunc ſequi ſcopum, nempe ut quod melius 'eſt eligat.' Galen *de Uſu Part. l.* 6. *c.* 13.

(*f*) *De Gubern. Dei.* l. 4. *p.* 1. 124. *meo libro*; alſo *l.* 7. *c.* 14.

CHAP. IV.

That God's Works ought to excite us to Fear, and Obedience to God.

SINCE the works of the Creation are all of them ſo many demonſtrations of the infinite wiſdom and power of God, they may ſerve to us as ſo many arguments exciting us to the conſtant fear of God, and to a ſteady, hearty obedience to all his laws. And thus we may make theſe works as ſerviceable to our ſpiritual intereſt, as they all are to our life, and temporal intereſt. For if whenever we ſee them, we would conſider that theſe are the works of our infinite Lord and Maſter, to whom we are to be accountable for all our thoughts, words, and works, and that in theſe we may ſee his infinite power and wiſdom; this would check us in ſinning, and excite us to ſerve and pleaſe him who is above all controul, and who hath our life and whole happineſs in his power. After this manner God himſelf argues with his own 'fooliſh people, 'and without underſtanding, who had eyes, 'and ſaw not, and had ears, and heard not, '*Jer.* v. 21, 22. Fear ye not me? ſaith the 'Lord: will ye not tremble at my preſence, 'which have placed the ſand for the bound 'of the ſea, by a perpetual decree, that it 'cannot paſs it; and though the waves thereof 'toſs themſelves, yet can they not prevail; 'though they roar, yet can they not paſs 'over it?'

This was an argument that the moſt ignorant, ſtupid wretches could not but apprehend, that a being that had ſo vaſt and unruly an element as the ſea, abſolutely at his command, ought to be feared and obeyed, and that he ought to be conſidered as the ſovereign Lord of the world, on whom the world's proſperity and happineſs did wholly depend; *ver.* 24, 'Neither

'Neither ſay they in their heart, let us now
'fear the Lord our God, that giveth rain,
'both the former and the latter in his ſeaſon:
'He reſerveth unto us the appointed weeks
'of the harveſt.'

CHAP. V.

That God's Works ought to excite us to Thankfulneſs.

AS the demonſtrations which God hath given of his infinite power and wiſdom ſhould excite us to fear and obedience; ſo I ſhall ſhew, in this chapter, that the demonſtrations which he hath given of his infinite goodneſs in his works, may excite us to due thankfulneſs and praiſe. It appears throughout the foregoing ſurvey, what kindneſs God, hath ſhewn to his creatures in providing every thing conducing to their life, proſperity, and happineſs (*a*); how they are all contrived and made

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(*a*) 'Sic pauca quis tibi donâſſet jugera, accepiſſe te diceres beneficium: immenſa terrarum latè patentium ſpatia negas eſſe beneficium? Si pecuniam tibi aliquis donaverit,---beneficium vocabis: tot metalla defodit, tot flumina emiſit in æra, ſuper quæ decurrunt ſola aurum vehentia: argenti, æris, ferri immane pondus omnibus locis obrutum, cujus inveſtigandi tibi facultatem dedit,----negas te accepiſſe beneficium? Si domus

made in the beſt manner, placed in the fitteſt places of the world for their habitation and comfort; accouter'd in the beſt manner, and accommodated with every, even all the minuteſt things that may miniſter to their health, happineſs, office, occaſions, and buſineſs in the world.

Upon which account, thankfulneſs and praiſe is ſo reaſonable, ſo juſt a debt to the Creator, that the Pſalmiſt calleth upon all the creatures to praiſe God, in *Pſalm* cxlviii. 'Praiſe him all his angels, praiſe him all his 'hoſts; ſun, moon, ſtars of light, heaven of 'heavens, and waters above the heavens.' The reaſon given for which is, *ver.* 5, 6. 'For he commanded, and they were created; 'he hath alſo eſtabliſhed them for ever and 'ever; he hath made a decree which they 'ſhall not paſs.' And not theſe celeſtials alone, but the creatures of the earth and waters too, even the meteors, 'fire and hail, ſnow and 'vapours, ſtormy winds, fulfilling his word.' Yea,

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'tibi donetur, in quâ marmoris aliquid reſplendeat, &c. Num mediocre munus vocabis? Ingens tibi domicilium, ſine ullo incendij, aut 'ruinæ metu ſtruxit, in quo vides non tenue 'cruſtas----ſed integras lapidis pretioſiſſimi moles, '&c. negas te ullum munus accepiſſe? Et cùm iſta 'quæ habes magno æſtimes, quod eſt ingrati hominis, nulli debere te judicas? Unde tibi iſtu 'quem trahis ſpiritum? Unde iſtam, per qua 'ductus vitæ tuæ diſponis atque ordinas, lucem '&c.' Senec. *de Benef.* *l.* 4. *c.* 6.

Yea, the very ' mountains and hills, trees, ' beaſts, and all cattle, creeping things, and ' flying fowl.' But in a particular manner, all the ranks and orders, all the ages and ſexes of mankind are charged with this duty; ' Let ' them praiſe the name of the Lord, for his ' name alone is excellent; his glory is above ' the earth and heavens, *ver.* 13.

And great reaſon there is we ſhould be excited to true and unfeigned thankfulneſs and praiſe (*b*) to this our great benefactor, if we reflect upon what hath been ſhewn in the preceding ſurvey, that the Creator hath done for

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(*b*) ' Tempeſtivum tibi jam fuerit, qui in hiſce ' libris verſaris, conſiderare, in utram familiam recipi malis, Platonicamne ac Hippocraticam, & ' aliorum virorum, qui Naturæ opera mirantur; ' an eorum qui ea inſectantur, quod non per pedes ' natura conſtituit effluere excrementa.' Of which having told a ſtory of an acquaintance of his, that blamed Nature on this account, he then goes on, ' At verò ſi de hujuſmodi pecudibus plura verba ' fecero, melioris mentis homines meritò mihi fortè ' ſuccenſeant, dicantque me polluere ſacrum ſermonem, quem ego *Conditoris* noſtri verum hymnum compono, exiſtimoque in eo veram eſſe pietatem,----ut ſi noverim ipſe primus, deinde & ' aliis expoſuerim, quænam ſit ipſius ſapientia, ' quæ virtus, quæ bonitas. Quod enim cultu conveniente exornaverit omnia, nullique bona inviderit, id perfectiſſimæ bonitatis ſpecimen eſſe ' ſtatuo; & hac quidem ratione ejus bonitas hymnis nobis eſt celebranda. Hoc autem omne inveniſſe,

ſor man alone, without any regard to the reſt of the creatures, which ſome have held were made for the ſake of man. Let us but reflect upon the excellence and immortality of our ſoul; the incomparable contrivance, and curious ſtructure of our body; and the care and caution taken for the ſecurity and happineſs of our ſtate, and we ſhall find, that among the whole race of beings, man hath eſpecial reaſon to magnify the Creator's goodneſs, and with ſuitable ardent affections to be thankful unto him.

' veniſſe, quo pacto omnia potiſſimùm adornaren-
' tur, ſummæ ſapientiæ eſt: effeciſſe autem omnia,
' quæ voluit, virtutis eſt invictæ.' Galen *de Uſu Part. l.* 3. *c.* 10.

C H A P. VI.

That we ought to pay God all due Homage, and Worſhip, particularly that of the Lord's Day.

FOR a concluſion of theſe lectures, the laſt thing I ſhall infer, from the foregoing demonſtration of the being and attributes of God, ſhall be, that we ought to pay God all that homage and worſhip which his right of creation and dominion entitle him unto, and his great mercies call for from us. And foraſmuch as the Creator appointed, from the very creation, one day in ſeven to his ſervice, it will not therefore be improper to ſay ſomething upon that ſubject: And if I inſiſt ſomewhat particularly and largely thereon, the congruity thereof to the deſign of theſe lectures, and the foregoing demonſtration, together with the too great inadvertency about and neglect of this ancient, univerſal, and moſt reaſonable and neceſſary duty, will, I hope, plead my excuſe. But that I may ſay no more than is neceſſary on this point, I ſhall confine myſelf to two things: The Time God hath taken, and the Buſineſs then to be performed.

1. The time is one day in ſeven, and one of the ancienteſt appointments it is, which God gave to the world. For as ſoon as God haſt finiſhed his ſix days works of Creation, it is ſaid, *Gen.* ii. 2, 3. 'He reſted on the ſeventh day from all his work which he had 'made And God bleſſed the ſeventh day, 'and ſanctified it, becauſe that in it he had 'reſted from all his work.' This ſanctification (*a*), and bleſſing the ſeventh day, was ſetting it apart, as a day of diſtinction from the reſt of the week-days, and appropriating it to holy uſes and purpoſes, namely, the commemoration of that great work of the creation,

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(*a*) 'קדש Uſibus divinis accommodavit, à 'communi & profano uſu ſegregavit, in uſum ſa'crum ad cultum Dei deſtinavit.' Kirch. *Concord.* *p.* 1336. 'Deſtinari ad aliquid, ſacrari, &c.' Buxtorf. *in Verbo.*

creation, and paying homage and worſhip to that infinite being, who was the effector of it.

This day, thus conſecrated from the beginning, for the celebration of the τȣ̃ κόσμȣ γενέσιον, the *World's Birth-day*, as Philo calls it, was probably in ſome meaſure forgotten in the following wicked ages, which God complains of, *Gen.* vi. 5. and ſo after the flood likewiſe. But after the return out of Egypt, when God ſettled the Jewiſh polity, he was pleaſed to renew this day, and to eſtabliſh it for a perpetual ſtanding law. And accordingly it was obſerved down to our bleſſed Saviour's time, countenanced, and ſtrictly obſerved, by our great Lord and maſter himſelf, and his Apoſtles and diſciples, in and after his time; and although for good reaſons the day was changed by them, yet a ſeventh day hath been conſtantly obſerved in all ages of chriſtianity, down to our preſent time.

Thus we have a day appointed by God himſelf, and obſerved throughout all ages, except ſome few, perhaps, which deſerve not to be brought into example.

And a wiſe deſignation of time this is, well becoming the divine care and precaution; ſerving for the recruiting our bodies and diſpatching our affairs, and at the ſame time to keep up a ſpiritual temper of mind. For by allowing ſix days to labour, the poor hath time to earn his bread, and the man of buſineſs time to diſpatch his affairs, and every man

time

time for the work of his reſpective calling. But had there been more, or all our time allotted to labour and buſineſs, and none to reſt and recruit, our bodies and ſpirits would have been too much fatigued and waſted, and our minds have been too long engaged about worldly matters, ſo as to have forgotten divine things. But the infinitely wiſe ruler of the world, having taken the ſeventh part of our time to his own ſervice, hath prevented theſe inconveniencies; hath given a relaxation to ourſelves, and eaſe and refreſhment to our wearied beaſts, to poor fatigued ſlaves, and ſuch as are under the bondage of avaricious, cruel maſters. And this is one reaſon Moſes gives of the reſervation and reſt of the ſeventh day, *Deut*. v. 13, 14, 15. 'Six days 'ſhalt thou labour, and do all thy work; but 'the ſeventh is the ſabbath of the Lord thy 'God; in it thou ſhalt not do any work, 'thou, nor thy children, ſervants, cattle, or 'ſtranger, that thy man-ſervant and maid-'ſervant may reſt as well as thou. And re-'member, that thou waſt a ſervant, &c. 'therefore the Lord thy God commanded 'thee to keep the ſabbath-day.' That carnal, greedy people, ſo bent upon gain, without ſuch a precept, would have ſcarce favoured their own bodies, muſt leſs have had mercy upon their poor bondſmen and beaſts; but by this wiſe proviſion, this great burden was taken off. But on the other hand, as a longer liberty

liberty would too much have robbed the maſter's time, and bred idleneſs, ſo by this wiſe proviſion, of only one day of reſt, to ſix of labour, that inconvenience was alſo prevented.

Thus the wiſe governor of the world hath taken care for the diſpatch of buſineſs. But then as too long engagement about worldly matters, would take off mens minds from God and divine matters; ſo by this reſervation of every ſeventh day, that great inconvenience is prevented alſo; all being then bound to worſhip their great Lord and Maſter, to pay their homages and acknowledgments to their infinitely kind benefactor; and, in a word, to exerciſe themſelves in divine, religious buſineſs, and ſo keep up that ſpiritual temper of mind, that a perpetual, or too long application to the world would deſtroy.

This, as it was a good reaſon for the order of a ſabbath to the Jews; ſo is as good a reaſon for our Saviour's continuance of the like time in the chriſtian church.

And a law this is, becoming the infinitely wiſe creator and conſervator of the world; a law, not only of great uſe to the perpetuating the remembrance of thoſe greateſt of God's mercies then commemorated, but alſo exactly adapted to the life, occaſions, and ſtate of man; of man living in this, and a-kin to another world: A law well calculated to the diſpatch of our affairs, without hurting our bodies or minds. And ſince the law is ſo wiſe

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and good, we have great reaſon then to practiſe carefully the duties incumbent upon us; which will fall under the conſideration of the

IId Thing I propoſed, the Buſineſs of the day, which God hath reſerved to himſelf. And there are two things enjoined in the commandment, a ceſſation from labour and worldly buſineſs; and that we remember to keep the day holy.

1. There muſt be a ceſſation from worldly buſineſs, or a reſt from labour, as the word Sabbath (*b*) ſignifies. 'Six days thou ſhalt do 'all thy work, but the ſeventh is the ſabbath 'of the Lord thy God (not thy day, but his) 'in which neither thou, nor any belonging 'to thee, ſhall do any work.' In which injunction it is obſervable, how expreſs and particular this commandment is, more than others, in ordering all ſorts of perſons to ceaſe from work.

2. We muſt 'remember to keep the day 'holy.' Which Remembrance is another thing alſo in this, more than in the other commandments, and implies,

1ſt, That there is great danger of our forgetting, neglecting, or being hinder'd from keeping the day holy, either by the infirmity and carnality of our own nature, or from the avocations of the world.

2dly, That the keping it holy, is a duty of more than ordinary conſequence and neceſſity. And of greateſt conſequence this is,

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(*b*) שבת *Ceſſatio, Requies.*

Firſt, To perpetuate the remembrance of thoſe grand works of God commemorated on that day; in the firſt ages of the world, the creation; in the middle ages, the creation and delivery from Egypt; and under chriſtianity, the creation and redemption by Chriſt. Which mercies, without ſuch frequent occaſions, would be ready to be forgotten, or diſregarded, in ſo long a tract of time as the world hath already ſtood, and may, by God's mercy, ſtill ſtand.

Secondly, To keep up a ſpiritual temper of mind, by thoſe frequent weekly exerciſes of religion, as hath been already mention'd.

Thirdly, To procure God's bleſſing upon the labours and buſineſs of our ſix days, which we can never expect ſhould be proſperous, if we are negligent of God's time. For how can we expect God's bleſſing upon a week ſo ill begun, with a neglect, or abuſe of God's firſt day? And therefore if we become unproſperous in the world; if loſſes, troubles, or dangers befal us, let us reflect how we have ſpent the Lord's day; whether we have not wholly neglected it, or abuſed it in riot, or made it a day for taking journeys, for more private buſineſs, and leſs ſcandalous labour, as the cuſtom of too many is.

Thus having ſhewn what reaſon there is to remember to keep holy the day dedicated to God, I ſhall conſider how we are to keep it holy, and ſo conclude. Now the way to keep it holy, is not by bare reſting from work; for that, as a father ſaith, is *Sabbatum Boum & Aſinorum*, a 'Sabbath of Beaſts:' But holy acts are the proper buſineſs for a holy day, celebrated by rational beings. Among all which, the grand, principal, and moſt univerſally practis'd, is the Publick Worſhip of God, the aſſembling at the Publick Place of his Worſhip, to pay (with our fellow-creatures) our homages, thanks, and praiſes, to the infinite Creator and Redeemer of the world. This, as it is the moſt reaſonable ſervice, and proper buſineſs for this day, ſo is what hath been the practice of all ages. It was as early as Cain and Abel's days, *Gen.* iv. 3. what was practiſed by religious perſons in the following ages, till the giving of the law; and at the giving of that, God was pleaſed to order places, and his particular worſhip, as well as the ſeventh day. The tabernacle and temple were appointed by God's expreſs command; beſides which, there were ſynagogues all over the nation; ſo that in our Saviour's time, every great town or village; had one, or more in it, and Jeruſalem 460, or more (*c*).

The worſhip of theſe places our bleſſed Saviour was a conſtant and diligent frequenter of. It is ſaid, 'He went about all the cities 'and villages, teaching in their ſynagogues, 'and preaching and healing, &c.' *Mat.* ix. 35. And

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(*c*) See *Lightfoot*'s works, *vol.* II. *p.* 35, and 646.

And St. Luke reporteth it as his conſtant cuſtom or practice, *Luke* iv. 16. 'And as 'his cuſtom was, he went into the ſynagogue 'on the ſabbath-day.'

Having thus mentioned the practice of Chriſt, it is not neceſſary I ſhould ſay much of the practice of his Apoſtles; and the following purer ages of chriſtianity, who, in ſhort, as their duty was, diligently follow'd their great maſter's example. 'They did not think 'it enough to read and pray, and praiſe God 'at home, but made conſcience of appearing 'in the publick aſſemblies, from which no'thing but ſickneſs and abſolute neceſſity did 'detain them; and if ſick, or in priſon, or 'under baniſhment, nothing troubled them 'more, than that they could not come to 'church, and join their devotions to the com'mon ſervices. If perſecution at any time 'forced them to keep a little cloſe; yet no 'ſooner was there the leaſt mitigation, but 'they preſently return'd to their open duty, 'and publickly met all together. No trivial 'pretences, no light excuſes, were then ad'mitted for any one's abſence from the con'gregation, but, according to the merit of 'the cauſe, ſevere cenſures were paſs'd upon 'them, &c.' to expreſs it in the words of one of our beſt antiquaries (*d*).

The Publick Worſhip of God then, is not a matter of indifference, which men have in their

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(*c*) Dr. Cave's *Primitive Chriſtianity*, part 1. cap. 7.

their own power to do, or omit, as they pleaſe; neither is it enough to read, pray, or praiſe God at home (unleſs ſome inevitable neceſſity hindereth) becauſe the appearing in God's houſe on his day, is an act of Homage and Fealty, due to the Creator, a Right of Sovereignty we pay him. And the withholding thoſe rights and dues from God, is a kind of rejecting God, and diſowning his ſovereignty, and withdrawing our obedience and ſervice. And this was the very reaſon why the profanation of the ſabbath was puniſh'd with death among the Jews, the ſabbath being a ſign, or badge of the God they own'd or worſhipped (*e*). Thus *Exod.* xxxi. 13.

‘ My

(*e*) As at this day it is cuſtomary for ſervants to wear the livery of their maſters, and others to bear badges of their order, profeſſion, ſervility, &c. So in former ages, and divers countries, it was uſual to bear badges, marks, and ſigns on divers occaſions. In *Ezek.* ix. 4. ‘ A mark was to be ſet on ‘ the forehead of thoſe that lamented the abomi‘ nations of the city.’ The like was to be done upon them in *Rev.* vii. 3. and ix. 4. So the worſhippers of the Beaſt, *Rev.* xiii. 16. were to receive a Χάραγμα, ‘ A mark in their right hand, ‘ on their foreheads.’ Thoſe Χαράγματα, Σφραγίδες, Badges, &c. were very common. Soldiers and ſlaves bare them in their arms or foreheads; ſuch as were matriculated in the Heteriæ, or companies, bare the badge or mark of their company; and whoever liſted themſelves into the ſociety of any of the ſeveral Gods, received a Χάραγμα, or a

‘ My ſabbaths ye ſhall keep; for it is a Sign between me and you, throughout your generation; that ye may know that I am the Lord, that doth ſanctify you;’ or as the original may be render’d, ‘A ſign to acknowledge, that I Jehovah am your ſanctifier, or your God:’ For as our learned Mede obſerves, ‘To be the ſanctifier of a people, and to be their God, is all one.’ So likewiſe very expreſly in *Ezek.* xx. 20. ‘Hallow my ſabbaths, and they ſhall be a ſign between me and you, that ye may know that I am the Lord your God;’ or rather, as before, ‘to acknowledge that I Jehovah am your God.’

The

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mark in his body (commonly made with red-hot needles, or ſome burning in the fleſh) of the God he had liſted himſelf under. And after Chriſtianity was planted, the Chriſtians had alſo their Sign of the Croſs. And not only marks in their fleſh, badges on their cloaths, &c. were uſual; but alſo the dedication of days to their imaginary Deities. Not to ſpeak of their feſtivals, &c. the days of the week were all dedicated to ſome of their Deities. Among the *Romans*, Sunday and Monday, to the *Sun* and *Moon*; Tueſday to *Mars*; Wedneſday to *Mercury*, &c. So our *Saxon* anceſtors did the ſame; Sunday and Monday (as the *Romans* did) to the *Sun* and *Moon*; Tueſday to *Tuyſco*; Wedneſday to *Woden*; Thurſday to *Thor*; Friday to *Friga*; and Saturday to *Seater*: An account of which Deities, with the figures under which they were worſhipped, may be met with in our learned *Verſtegan*, *chap.* 3. *p.* 68.

The ſabbath being thus a ſign, a mark, or badge, to acknowledge God to be their God, it follows, that a neglect or contempt of that day, redounded to God; to ſlight that, was ſlighting God; to profane that, was to affront God; for the puniſhment of which, what more equitable penalty than death? And although under chriſtianity the puniſhment is not made capital, yet have we no leſs reaſon for the ſtrict obſervance of this holy day, than the Jews, but rather greater reaſons. For the God we worſhip, is the ſame: If after ſix days labour, he was, by the ſeventh, own'd to be God the Creator; no leſs is he by our chriſtian Lord's day: If by the celebration of the ſabbath, the remembrance of their deliverance from the Egyptian bondage was kept up, and God acknowledged to be the effecter thereof; we chriſtians have a greater deliverance, we own our deliverance from ſin and Satan, wrought by a greater redeemer than Moſes, even the Bleſſed Jeſus, whoſe reſurrection, and the completion of our redemption thereby, was perform'd on the chriſtian Lord's day.

And now, to ſum up, and conclude theſe inferences, and ſo put an end to this part of my ſurvey: Since it appears, that the works of the Lord are ſo great, ſo wiſely contrived, ſo accurately made, as to deſerve to be enquired into; ſince they are alſo ſo manifeſt demonſtrations of the Creator's being and attributes, that all the world is ſenſible thereof, to the great reproach of Atheiſm; what remaineth, but that we fear and obey ſo great and tremendous a being? That we be truly thankful for, and magnify and praiſe his infinite mercy, manifeſted to us in his works? And foraſmuch as he hath appointed a day on purpoſe, from the beginning, for theſe ſervices, that we may weekly meet together, commemorate and celebrate the great work of creation; that we may pay our acts of devotion, worſhip, homage, and fealty to him; and ſince this is a wiſe and excellent diſtribution of our time, what ſhould we do, but conſcientiouſly and faithfully pay God theſe his rights and dues? and as carefully and diligently manage God's time, and diſcharge his buſineſs then, as we do our own upon our ſix days; particularly that with the pious Pſalmiſt, 'We love the habitation of God's houſe, and the place where his honour dwelleth;' and therefore take up his good reſolution in *Pſal.* v. 7. with which I ſhall conclude; 'But as for me, I will come into thine houſe in the multitude of thy mercy, and in thy fear will I worſhip towards thy holy temple.'

Now to the ſame infinite God, the omnipotent Creator and preſerver of the world, the moſt gracious redeemer, ſanctifier, and inſpirer of mankind, be all honour, praiſe, and thanks, now and for ever. *Amen.*

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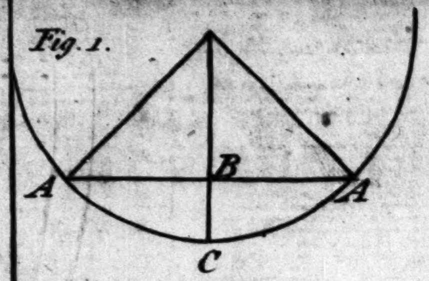

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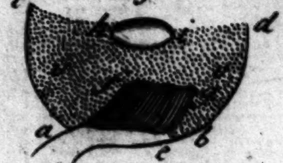

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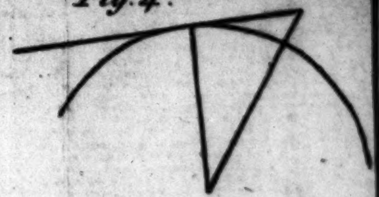

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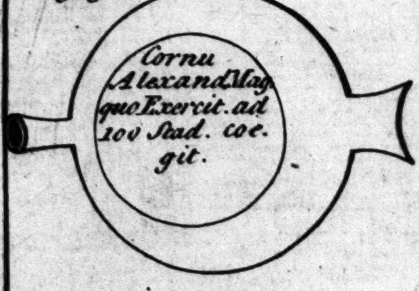

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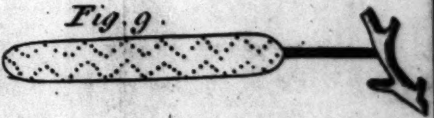

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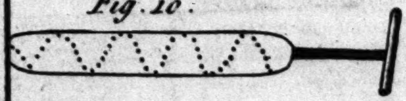

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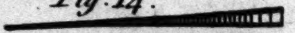

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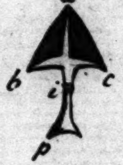

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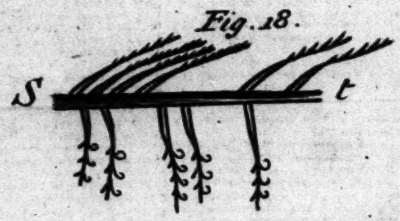

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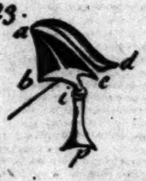

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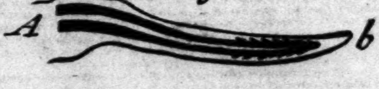

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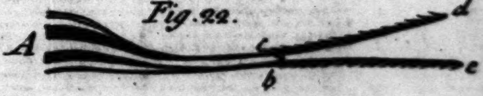

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